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LONDON MEDICAL SOCIETY

PHYSIOLOGY;

OR,

An ATTEMPT to EXPLAIN

THE

FUNCTIONS AND LAWS OF THE NERVOUS SYSTEM; THE
CONTRACTION OF MUSCULAR FIBRES; AND THE CONSTANT AND INVOLUNTARY ACTIONS OF
THE HEART, THE STOMACH, AND
ORGANS OF RESPIRATION,
BY MEANS OF SIMPLE, UNIVERSAL, AND UNVARYING
PRINCIPLES.

TO WHICH ARE ADDED,
OBSERVATIONS
ON THE
INTELLECTUAL OPERATIONS OF THE BRAIN;
AND ON THE
DIVERSITY of SENSATIONS:
WITH
REMARKS
ON THE
Effects of Poiſons;
AND
AN EXPLANATION OF THE EXPERIMENTS
OF
GALVANI AND OTHERS,
ON
ANIMAL ELECTRICITY.

By E. PEART, *M. D. &c.*

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PREFACE.

WITHIN the laſt eight or nine years I have frequently offered my ſentiments to the public on various philoſophical ſubjects. I have rejected the commonly received opinions on the general principles and operations of nature, becauſe they are *abſurd*; but I have never rejected them without firſt of all proving that they are ſo. I have propoſed the principles upon which I have founded my own theory, but not without proving, as far as the nature of the ſubject will admit, that thoſe principles do actually exiſt; and the laws by which they are regulated are deduced from facts which nature every moment preſents to our view.

That the chemical doctrines of M. Lavoiſier, and the electrical theory of Dr. Franklin, are founded on *abſurd principles*, and are, therefore, *erroneous*, I have *proved* by ſuch arguments as I do not for a moment heſitate to aſſert, are abſolutely concluſive: whatever, therefore, may be the fate of my own theory, *theirs*, to a certainty, *are falſe*. With reſpect to my own *principles*, I feel as confident of their exiſtence as of my own; how far I have ſucceeded in developing the *laws* by which they are governed is another matter;—many of my conjectures may be erroneous, and much remains to be diſcovered. Confidence, however, may be miſplaced; and I have all along declared, and ſtill declare, that I would not for a moment heſitate to *abandon* both my *theory* and *principles* were they once proved to be *fallacious*.

That the theories of Dr. Franklin and M. Lavoiſier are *generally adopted* is granted; but, that is *no proof* that they are either *true* or *rational*.

Reaſon never was, nor now is neceſſary, to eſtabliſh an opinion; witneſs the number of doctrines which have been advanced, embraced, and forgotten! neither is the general aſſent of a million any proof of veracity, for no opinion is *too abſurd* to want converts, as is evident in *philoſophy* as well as *religion.*

When I read in a modern publication of celebrity, that venous blood attracts oxygen from the azote of atmoſpheric air, and in the next paragraph that azote attracts oxygen from blood, without any reaſon why or wherefore, can I call it philoſophy? Surely not—the aſſertions manifeſtly contradict each other, and the theory which reſts upon ſuch principles and explanations, appears to me rather *contemptible* than ſatiſfactory.

When I am told that the brain ſecretes the *electric fluid*, and that the tranſmiſſion of a portion of the electricity to any particular nervous fibre, cauſes the muſcle to which it is diſtributed, to act—what am I to underſtand?—The ſame philoſopher as being of the Franklinian ſchool, allows that the brain cannot communicate its poſitive electricity to a muſcle, unleſs *that muſcle* be *negative*: the will, then, inſtead of tranſmitting electricity from the brain, muſt act upon the *muſcle* by rendering it *negative*, and then the electric fluid of the brain ruſhes to the muſcle to reſtore the equilibrium :—but, when the muſcle was *not* in action, it had its uſual proportion of electric power ; how did the will, then, diſpoſe of that natural electric power when it rendered the muſcle negative ?—in ſhort, the opinion is prepoſterous !—The powers of the brain and nerves *cannot* be in an *electric ſtate* ; for it is an undoubted fact that the nerves are conductors of electricity, and that the electric fluid communicated to *any part* of the common trunk of a nerve, will affect *every fibre*, and will excite *every* terminating branch of that nerve ;—but the *voluntary* act of the mind can tranſmit its power to *one ſingle* muſcle *alone*, though the nerves connected with ten thouſand other muſcular fibres were collected into the ſame bundle ſo as together to conſtitute one nerve.

When I am aſſured that the blood by circulating through the arteries to a muſcle, returns by the veins, loaded with powdered charcoal, can I avoid aſking how and where it acquired its charcoal?—And when I am told that the charcoal thus mixed with the venous blood, combines with oxygen gas in the lungs, and forms fixed air,—can I avoid being ſtruck with the ſingularity, that ſimple charcoal can combine with oxygen gas *in* the lungs, at the temperature of 96°, when charcoal *out* of the lungs might be expoſed to the ſame air to eternity, without producing fixed air, unleſs a *much greater* degree of heat were employed!—the charcoal *in* the lungs, then, *cannot* be in the *ſame ſtate* as the charcoal *out* of the lungs; and ſome principle or cauſe is overlooked, which renders the antiphlogiſtic doctrine lame, imperfect, and unſatisfactory.

When I am gravely informed, that the air which almoſt inſtantly congeals the blood of the hardy Siberian himſelf, is formed of 999 parts out of the 1000 of pure, genuine, elementary *Fire*, can I tell which the moſt to admire,—the *abſurd fancy* of the firſt conceiver of ſuch an idea, or the *wonderful credulity* of the multitudes, who ſwallow the abſurdity as they do the goſpel!—

When I read, in every periodical work, from the Tranſactions of the Royal Society, down to the humble Review, that the proud *diamond* itſelf is nothing more than cryſtallized *charcoal,*—what can I add—but, that when the readieſt and beſt method of *thus cryſtallizing charcoal,* is clearly pointed out, I will confeſs, that the diſcovery is as *brilliant* as it is now wonderful! wonderful! wonderful!

According to the antiphlogiſtic ſyſtem, carbon, azote, and hydrogen, are three diſtinct principles; but as each of them is capable of *combining* with the *acid* principle and of *ſaturating* it, more or leſs completely; and as they are mutually convertible into each other, as is too well known to the antiphlogiſtians to need inſiſting upon, I heſitate not to affirm, that they are *one* and the *ſame principle*, in different ſtates of purity, with reſpect to the admixture of other matters, and with different proportions of the *power* by which they are rendered atmoſpheric; and that principle I diſtinguiſh by the name of the *alkaline* or the *antacid* principle; which, therefore, includes both carbon, azote, and hydrogen.—In chemiſtry, thoſe diſtinctions are uſeful; but as my preſent ſubject does not require the ſpecification of the *peculiar* ſtates of the antacid principle, the general term *alone* is employed in the following tract.

But to conſider all the abſurdities and contradictory concluſions of the antiphlogiſtic doctrine, would be an unneceſſary repetition of what I have already more fully accompliſhed. That it is *puerile* and *unphiloſophical*, I aſſert, without the moſt *diſtant fear* of contradiction; and that the Franklinian doctrine of electricity is, if poſſible, ſtill *more abſurd*, I have proved to a demonſtration, on former occaſions; and have, repeatedly, called upon its admirers to defend it—but in vain.

As the ſubject of this tract is chiefly phyſiological, I cannot refuſe myſelf the gratification of acknowledging how much I feel myſelf indebted to my firſt, great, teacher, the juſtly celebrated Dr. Monro, profeſſor of anatomy at Edinburgh. The extent of his knowledge, the ſolidity of his judgment, and the penetration of his diſcernment, impreſſed my mind with that *profound reſpect* which I ſhall retain while I have recollection.

Neither can I forget, nor recollect without cheerfully confeſſing the many obligations that I think myſelf under to Mr. Cruikſhank. His lectures were replete with information, his wiſh to inſtruct was equal to his well-known abilities as a teacher, and his liberality in collecting information from every ſource, was not leſs conſpicuous than his readineſs to communicate it.

For the late celebrated Dr. Hunter my eſteem is ſincere and unabated; his pleaſing manner, ſo much his own, of rendering his ſubject intelligible to every capacity, could not fail of affording *me* many advantages which I am proud to acknowledge.

There are ſome few philoſophical characters, for whom, though unknown, I have that reſpect which is ſo juſtly their due; and to whom I ſhall take the liberty of preſenting this little tract, as a teſtimony of that eſteem which I feel for men of *ſcience* and *liberality*, howſoever they may differ from me in opinion: the peruſal may afford them an hour's amuſement, and, although I expect *no converts*, ſomething may, perhaps, occur, which may excite their attention, and lead to future improvements.

Upon a ſubject like this, much muſt be left to conjecture; and plauſibility muſt ſtand in the place of demonſtration; it being, perhaps, as impoſſible to demonſtrate, by diſſection, the various ſtructure, connexions, and exact organization of the brain, as it is by the powers of optical ſcience, to detect the intellectual powers themſelves, in the act of thinking.

Strongly convinced as I am of the value of experiments, I ſtill am equally convinced, that diligent attention and accurate reaſoning are equally neceſſary, without which, experiments are labour in vain.

As no ſimple experiment can ſhow why the heart conſtantly beats—how the eye ſees—or the brain perceives and reaſons—I have ventured to collect what facts have come to my knowledge, and from thoſe facts I have endeavoured, by reaſon and analogy, to inveſtigate the reſt, as far as the limited powers of my mind have been able, *directly*, and *extemporaneouſly* to proceed.

I have in no caſe, that I know of, made unfair ſtatements, or drawn unwarrantable concluſions; neither have I propoſed one new principle, idea, or explanation, without giving the reaſon why, nor without being led to do ſo, by ſuch previous arguments and reaſons, as appeared to me ſatisfactory at the time.

I by no means, however, offer this as a finiſhed work upon the ſubject; the reſult of *twenty years* mature deliberation:—on the contrary, I declare, candidly, that it was *begun* upon, merely as a winter-evening's amuſement, and *finiſhed* in *leſs* than *twice* that number of *evenings.*

I pretend to no order, or method, but what ſpontaneouſly aroſe in the proſecution of my ſubject; nor to any elegance of language, or choice of terms,—thoſe expreſſions *only* being employed which aroſe ſimultaneouſly with the ideas.

In fact, I honeſtly confeſs that I think and write merely for my amuſement—and as I have *no* expectations of making converts to my peculiar opinions, I by no means feel diſpoſed to convert amuſement into *labour*, by the drudgery of *correcting* and *tranſcribing.*

As, however, many of the ideas in this tract are *new*, I preſent them undigeſted and extemporaneous as they are, to thoſe few who have *capability* to underſtand, and *liberality* to conſider them impartially. If they have inclination to attend to the ſubject, my wiſh *is*, that they may meet with ſomething worthy of *their* attention ;—ſomething which may tend to the improvement of ſcience ; —ſomething which may render their labour not in vain.

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BOOKS

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PHYSIOLOGY.

SECTION I.

A general view of the ſyſtem of the human body.

1. THE human body is formed of ſolids and fluids, of different degrees of firmneſs and conſiſtency; and of different properties; as being compoſed of different principles in various proportions, and modes of combination and arrangement.

2. The more ſolid parts are the bones; theſe give form and ſtrength, and conſtitute the baſis to which the ſofter parts are attached; and

by which, parts of the greateſt importance are defended.

3. The matter generally employed in forming and connecting the parts together, is ſimply fibrous or membraneous; of this the veſſels, neceſſary in the ſyſtem, are in a great meaſure compoſed; and by it parts of different kinds are connected together, in variety of combinations.

4. The actions or peculiar functions of the ſyſtem, however, chiefly depend upon the brain and nerves; the heart and blood-veſſels; and the moving, or muſcular fibres.

5. The brain and nerves conſtitute the moſt refined and wonderful part of the general ſyſtem. They are connected together; or, perhaps, the nerves are, in general, merely productions, or elongations of the brain, from which they proceed, as from a common centre; for the purpoſe of conveying the energetic influence of the brain to diſtant parts; where that

influence is neceſſary to produce the functions of the parts to which they are diſtributed, or for the purpoſe of communicating impreſſions made on the nervous extremities to the brain.

6. The heart and blood-veſſels are the next important part of the ſyſtem. The heart is the centre from which the blood-veſſels proceed, or to which they tend;—and the arteries are ſo contrived, as to tranſmit the blood to the moſt diſtant parts, where its influence is required to aſſiſt in the peculiar functions of thoſe parts; while the veins convey it back to the heart, after its influence has been imparted.

7. The muſcular fibres are equally neceſſary in the ſyſtem as the former; for they, alone, poſſeſs the power of motion, or contraction; and, conſequently, without them an univerſal inertia would prevail, and the body would be an immoveable, inactive maſs.

8. The brain and nerves are the only ſentient parts of the ſyſtem. Impreſſions made upon

the nerves, when ſufficiently powerful to excite the attention of the intellectual powers of the brain, conſtitute ſenſations; the affection of the nerve being communicated to the brain, if nothing obſtructs its courſe.

9. The nerves are an eſſential part in the conſtruction of the muſcular, or contracting fibres of the body; for without their preſence and agency, muſcular fibres are inactive.

10. The heart itſelf is a muſcle; and the extremities of the blood-veſſels are alſo muſcular. The heart contains a number of blood-veſſels in its ſtructure; and the muſcular activity of a part, or of the whole ſyſtem, greatly depends upon the preſence of blood; therefore, the blood is requiſite to muſcular action; and, conſequently, the blood-veſſels are an eſſential part in the compoſition of muſcular fibres.

11. Muſcular fibres, therefore, require both nerves and blood-veſſels in their conſtruction.

12. But, a muſcle, though formed of nerves and blood-veſſels, cannot act without the preſence of blood; neither will the voluntary muſcles act, although blood be circulating through them, without the influence of the nerves:—conſequently, a muſcular fibre has both nerves and blood-veſſels in its ſtructure; and its action depends upon the flow of blood by theſe veſſels, and of the nervous influence by the nerves; by the conjoint influence of which blood and nervous energy, the muſcular fibre is made to contract.

From theſe conſiderations then we may conclude—

1ſt. That the brain and nerves, and the heart and blood-veſſels are the chief ſources, of all the powers, by which the different functions of the ſyſtem are produced.

2d. That the nerves and blood-veſſels are eſſential parts in the conſtruction of muſcular fibres.

3d. That the energetic powers of the nerves, co-operating with the blood of the ſanguiferous veſſels, cauſe the muſcular fibres to contract; and,

4th. That all the actions of the body are produced, conjointly by the nervous and ſanguiferous ſyſtems, imparting the influence or fluids they convey to the muſcular fibres, into whoſe compoſition they enter.

SECTION II.

On the brain and nerves; and on the heart and ſanguiferous veſſels, with the blood which they convey.

1. THE brain is compoſed of the cerebrum and cerebellum. They are diſtinct portions; differently conſtructed and ſituated; but wonderfully and intimately connected together.

2. The cerebrum and cerebellum, conjointly, form the medulla oblongata; the medulla ſpinalis, and every nerve in the body; ſo far as it is poſſible to be aſcertained.

3. It is reaſonable then to conclude, that the nerves of the cerebrum are eſſentially different in their nature, or general properties, from thoſe of the cerebellum; conſequently, that the influence, of whatever kind, or nature it may be,

which is conveyed by the nerves of the cerebrum, is eſſentially different from that tranſmitted by the nerves of the cerebellum; for, if the nerves of both cerebrum and cerebellum were of the ſame nature, and conveyed an influence exactly ſimilar in its powers and properties, there could be no reaſon given why they are thus derived from diſtinct origins, and ſo carefully diſtributed to every part from each origin.

4. The ſanguiferous ſyſtem is peculiarly deſtined to convey the blood; which is as neceſſary in the operations of the ſyſtem as the influence of the nerves is.

5. The blood is not an homogeneous fluid; it muſt be formed of thoſe things which are neceſſary, eſſentially neceſſary, to ſupport life; and thoſe eſſential requiſites, are directly the reverſe of each other, in their general properties.

6. One thing indiſpenſably neceſſary to the ſupport of life, is air; atmoſpheric air; or rather the pure air in the atmoſphere. The other eſ-

ſential requiſite is food—if either, or both of theſe be wanting, the functions of the ſyſtem ceaſe, and death enſues: if air be withheld, life is very ſoon deſtroyed; if food be denied, death is equally certain as the conſequence, but at a more protracted period.

7. Air without food, cannot long ſupport the vital powers; neither can food without air: conſequently, they are eſſentially different from each other in their properties and nature.

8. What then is the leading property of the air, ſo neceſſary to ſupport life? There are different kinds of air; but it is the pure, vital, dephlogiſticated or oxygen gas, or air, alone which is required; becauſe thoſe kinds of air which contain it in the greateſt purity and proportion, are the moſt ſalutary; and thoſe ſpecies of air, which do not contain it, are deſtructive, or at leaſt cannot ſupport life.

9. It is then oxygen, or the acid, or acidifying principle, in the ſtate of air, which is one

eſſential requiſite; without which life cannot be ſupported.

10. What is the other principle, which muſt be of a different nature, (5) which is equally neceſſary to ſupport the life of an animal? It is obtained from food of different kinds; chiefly vegetable, animal, or produced from one or both of them; and its ſpecific properties may be the beſt aſcertained, by conſidering what it is which affords the moſt ſpeedy and evident ſupport to the powers of life, when taken into the ſtomach.

11. We know then that wine and ſpirituous liquors produce the moſt ſudden and invigorating effects upon the ſtomach. Spirituous liquors evidently contain an antacid or alkaleſcent principle; becauſe, if ardent ſpirits or alcohol, which is the moſt pure and potent, be expoſed to the action of pure air, or oxygen gas, and accended; the air will loſe its aeriform ſtate; the alcohol its ſpirituous qualities; and water will be the reſult of their combination:—but we know that pure air, or oxygen gas, is formed

of the acidifying principle; we know that, in many caſes, when it is deprived of its aeriform ſtate, it conſtitutes an acid; therefore, as it is deprived of its aeriform ſtate by combuſtion with alcohol, and with it forms a fluid which has no acidity; it is evident, that the baſis of the alcohol ſaturates the oxygen, or acidifying principle of the air; and muſt therefore be of an antacid or alkaleſcent nature.

12. Alcohol and vitriolic ether afford immediate ſupport or excitement to the ſyſtem when taken into the ſtomach; and they are little different from inflammable air, or hydrogen gas; as is very evident from their being eaſily converted into inflammable air; and from their forming water when accended with pure air or oxygen gas, as inflammable air itſelf does.

13. It is evident then that ether and alcohol are of the ſame nature; compoſed of the ſame principles; and nearly in the ſame proportions as inflammable air: and the chief difference is, that inflammable air is the moſt diſengaged, and

in an aeriform ſtate; while the ſame principles in alcohol and ether, are combined with ſome other principle, which detains them in a more condenſed ſtate; or, otherwiſe, they only differ in the proportion of that fluid which renders the alkaleſcent, or antacid principle, aeriform.

14. What is the principle which renders oxygen or the acidifying principle aeriform? and what the principle which renders the antacid, or alkaleſcent principle aeriform, ſo as to conſtitute inflammable air? Is it fire or caloric? or is it any one principle common to both pure and inflammable air; which, by acting upon the acidifying and alkaleſcent principles, combines with them, ſo as to render them aeriform? No, it cannot be one principle;—becauſe, when a few grains of oxygen, or of the acidifying principle, are converted into air; thoſe particles are removed far from each other, ſo as to expand into a fluid occupying a much greater ſpace than before; conſequently, each particle of oxygen muſt be ſurrounded with an atmoſphere; and as thoſe atmoſpheres prevent the particles of oxygen from approaching near to each other, they

muſt repel, or reſiſt each other, and cannot have any attraction for each other, ſo as to enable them to combine.

In like manner when the alkaleſcent principle is converted into inflammable air, each alkaleſcent particle muſt be ſurrounded by an atmoſphere, which reſiſts the approach of every other ſimilar atmoſphere; therefore, the atmoſpheres rendering the antacid or alkaleſcent particles aeriform, being ſimilar, have no attraction to each other, by which they can combine. But, if the pure air, or oxygen gas be mixed with hydrogen gas, or inflammable air, they may readily be made to attract each other and combine; leaving the acidifying and alkaleſcent particles united together, in a ſtate of perfect neutrality, conſtituting water.

15. It is evident then, that there are two diſtinct principles, or powers; one of which will convert oxygen, or the acidifying principle, into pure air; and the other will convert the antacid, or alkaleſcent principle, into inflammable air: that the atmoſpheres ſurrounding the

particles of oxygen, have no attraction for each other; that the atmoſpheres ſurrounding the alkaleſcent particles, have no attraction for each other; but, that the atmoſpheres ſurrounding the acidifying principle, attract, and will combine, with the atmoſpheres which render the particles of the alkaleſcent principle aeriform: in conſequence of which combination, the acid and alkaline particles are left, without thoſe atmoſpheres, combined together, ſo as to conſtitute water; and, from the quantity of fire and light, which is produced during the combination, there can be no reaſon to doubt, that thoſe two atmoſpheres, by combining together, and quitting their aeriform ſtates, conſtitute the fire, and excite the light, which appear at the inſtant of their combination.

16. It appears, then, that the alkaleſcent, or antacid principle, is an eſſential requiſite to ſupport the functions of the living body; that thoſe ſubſtances which contain it in the pureſt and moſt abundant ſtate, are the moſt powerful in ſupporting the immediate operations of the ſyſtem; and that all ſubſtances, whether animal or

vegetable, which are capable of ſupporting life, contain this principle in ſome ſtate and proportion or other.

17. But, it is not the acidifying principle, or oxygen, ſimply, alone, which is requiſite; nor the pure alkaleſcent principle; nor the two together, which can ſupport the ſyſtem: on the contrary, the acid principle muſt be in the aeriform ſtate, by means of its peculiar power in an atmoſpheric ſtate ſurrounding its particles; and the alkaline principle muſt be attended with its peculiar power, which renders it aeriform, though not uncombined, or ſo abundant as to render its particles in an aeriform ſtate: conſequently, the functions of the ſyſtem require for their ſupport the acid principle rendered aeriform by its peculiar power; and the alkaline principle, combined with certain proportions of that peculiar power, which, in a larger proportion, or in a ſtate of freedom, would convert it into inflammable air.

I have ſo repeatedly inveſtigated this ſubject, and come to the ſame concluſions, in whatever manner or direction the inveſtigation has been purſued, that I feel the greateſt confidence in the veracity of theſe principles: and, as, upon former occaſions, I have found it neceſſary to apply diſtinct appellations to the principles in queſtion, for the purpoſe of more ready and diſtinct diſcrimination; ſo I ſhall, here, obſerve the ſame method.

Oxygen, or the acidifying principle, then, I ſhall call, for conveniency, the acid principle.

Hydrogen, or the alkaleſcent principle, I ſhall diſtinguiſh by calling it the antacid, or the alkaline principle; which, alſo, by partial combinations with the other principle, and the powers in different proportions, forms the different kinds of earths.

That peculiar power, or fluid, or principle, which renders the particles of the acid principle aeriform, by becoming atmoſpheric around them, I ſhall diſtinguiſh by the title of æther, or the æthereal power; and, the fluid, power, or principle, which, in an atmoſpheric ſtate around the particles of the alkaline principle, renders them aeriform; I ſhall call phlogiſton, or the phlogiſtic power.

From the preceding conſiderations, then, I draw the following general concluſions:

1ſt. That the brain conſiſts of two diſtinct ſubſtances; of different powers, and properties: the cerebrum, and cerebellum.

2d. That they are intimately connected together, and invariably accompany each other, in all their ramifications.

3d. That every common nerve is connected with the cerebrum and cerebellum; and, therefore, that every nerve is compoſed, in fact, of a branch from the cerebrum, and another from the cerebellum.

4th. That every branch of nerve connected with the cerebrum, contains and conveys a peculiar energy, fluid, or power; that every branch from the cerebellum contains and conveys a peculiar fluid, or power, alſo; but, eſſentially different in its properties from the former; and, conſequently, that every common nerve is compoſed of a nervous branch from the cerebrum, and another from the cerebellum; each of which is ſupplied with its peculiar power, eſſentially different from the other.

5th. That the heart and ſanguiferous veſſels contain and convey the blood; which is compoſed of two diſtinct principles, with their reſpective powers in chemical combination.

6th. That the blood derives its principles and ſupport, from the atmoſpheric air, conſtantly taken into the lungs; and from the food repeatedly taken into the ſtomach.

7th. That the principle taken from the air is the acid principle, rendered aeriform by the æthereal power.

8th. That the principle ſelected and acquired from the food is the alkaline, or antacid principle; combined with a portion of the phlogiſtic power.

9th. That the blood, thus conſtantly ſupplied with the acid principle, with its æthereal power; and with the alkaline principle, with its phlogiſtic power; is capable, by co-operation with the nerves and their reſpective powers, of producing all the functions of life; all the actions and operations of the human ſyſtem.

SECTION III.

On the powers of the brain and nerves; by which they produce their effects upon muſcular fibres.

1. IT has been concluded on probable grounds, (ſect. ii. 2. 3.) that the cerebrum and cerebellum, and their reſpective nerves, are eſſentially different from each other, with reſpect to their general properties; and the fluids, energies, or powers which they contain and convey, when excited to action.

2. What are thoſe fluids, or powers; and from whence are they derived? Certainly from the blood; and the blood acquires them from the air and food, which are ſo neceſſary to ſupport the life and animation of the brain.

3. If a man be deprived of a conſiderable

quantity of blood, he faints; if the loſs be very great, he dies.

If a man be prevented from breathing pure air, the functions of the brain quickly languiſh; the ſenſes and reaſoning powers are ſuſpended; and perfect inſenſibility and inconſciouſneſs uſher in death.

If he be deprived of food, all the powers of the body and mind gradually diminiſh; and a total ceſſation of all the functions of the ſyſtem, or death, is the conſequence.

Air of the pureſt kind without food, cannot preſerve the powers of the brain; and the moſt generous food and exhilarating cordials are applied in vain, to ſupport and excite the faculties of the brain, if air be wanting.

4. It is evident, then, that the functions of the brain and nerves immediately depend upon the blood; becauſe if the brain be not largely

ſupplied with blood, its powers and functions are diminiſhed, or entirely ceaſe.

It is equally certain, that the blood with which the brain is ſupplied, muſt contain both the principles which it acquires from the air and from food; for if the blood be deprived of either, or both of thoſe principles, the functions of the brain are ſuſpended, or deſtroyed. It is evident, therefore, that the brain does acquire from the blood, either the acid principle with its æthereal power, and the alkaline principle with its phlogiſtic power; otherwiſe it ſeparates from the blood the æthereal and phlogiſtic powers, and leaves the acid and alkaline principles combined in the blood.

5. The brain, then, does ſeparate and acquire from the blood, either the two powers; or the two principles with their powers combined with them; becauſe, without a conſtant ſupply of blood its functions ceaſe; and, without a conſtant ſupply of air and food, the blood is incapable of ſupporting thoſe functions.

6. But, the principles which the brain acquires from the blood, are applied to the purpoſe of ſupporting the actions of the ſyſtem:—thoſe principles, then, are tranſmitted from the brain, along the nerves, to the muſcles. If we conſider the extreme minuteneſs, or exility of the nervous fibres, which convey theſe powers from the brain; and the rapidity of the motion with which thoſe powers are tranſmitted along the nerves; it will appear highly improbable to ſuppoſe that the acid and alkaline principles themſelves, are propelled along the nerves; and, it is therefore reaſonable to conclude, that the brain does, in reality, ſeparate and acquire from the blood, the æthereal and phlogiſtic powers only; completely diſengaged from their reſpective acid and alkaline principles; which are, therefore, left combined in the blood.

7. We may then reaſonably conclude, that the brain and nerves do ſeparate from the blood the æthereal and phlogiſtic powers; that thoſe powers, when excited, rapidly flow along the nerves to aſſiſt in the neceſſary actions of the

parts to which they are diſtributed; that they are diſcharged from the nerves when they produce thoſe actions; that a conſtant ſupply of thoſe powers from the blood is neceſſary to replace the æthereal and phlogiſtic powers expended in thoſe actions; and, that a conſtant ſupply of air and food is therefore requiſite to enable the blood to afford thoſe neceſſary ſupplies to the brain and nerves.

8. As the æthereal and phlogiſtic powers, then, are eſſentially neceſſary to ſupport the functions of the brain; and by being excited to flow along the nerves, produce the various actions of the ſyſtem; and, as the brain and the nerves proceeding from it are evidently of two diſtinct kinds; the cerebrum and cerebellum; it is natural to ſuppoſe, that the cerebrum and its nervous fibres, particularly, ſecrete and convey one of thoſe powers; and the cerebellum and its nerves the other. Two diſtinct powers, or principles, are evidently requiſite to ſupport the functions of the brain; and, as the cerebrum and cerebellum are diſtinct portions of the brain,

there can be no reaſon given why thoſe parts are ſo diſtinctly formed, unleſs it be, that each may ſecrete its diſtinct power, or active principle, from the blood: and, as the medulla oblongata and medulla ſpinalis, from which the nerves proceed, are evidently formed of fibres from both the cerebellum and cerebrum; it is reaſonable to conclude, that every common nerve is compoſed of fibres from both the cerebrum and cerebellum; and, that every fibre is ſupplied with that peculiar power, which is ſecreted from the blood, by that portion of the brain to which it is immediately connected.

I hold it, therefore, perfectly allowable to draw the following concluſions:

1ſt. That the brain ſeparates from the blood the æthereal and phlogiſtic powers; pure and uncombined with the acid, or alkaline principles.

2d. That the brain evidently conſiſts of two diſtinct portions, of different organization, and form; and, that the cerebrum ſeparates from the blood, one of thoſe powers only; and the cerebellum the other.

3d. That the nerves connected with, or ariſing from the cerebrum, contain and convey the ſame power as the cerebrum ſeparates from the blood; and that the nerves of the cerebellum, only convey that power, or kind of power, which is peculiarly ſecreted by the cerebellum.

4th. That all the nerves being derived from the medulla oblongata and ſpinalis, are formed of diſtinct fibres, from both the cerebrum and cerebellum; which mutually compoſe and conſtitute the medulla oblongata and medulla ſpinalis.

5th. That every common nerve thus formed, and conſiſting of diſtinct fibres from the cerebrum and cerebellum, does contain both the æthereal and phlogiſtic powers; the fibres ariſing from the cerebrum, diſtinctly poſſeſſing one power; while the fibres from the cerebellum diſtinctly contain the other.]

6th. That when theſe powers are excited, they flow along the common nerve, to the parts whoſe actions they are concerned in producing; and are there diſcharged from the nervous extremities.

7th. That the brain muſt require a ſupply of æthereal and phlogiſtic powers from the blood, equal to the expenditure in producing the actions of the ſyſtem; and, conſequently, that the neceſſity of air and food to reſtore thoſe principles to the blood, muſt equal the degree of action in the ſyſtem, by which they are expended.

SECTION IV.

On the action or contraction of muſcular fibres.

1. MUSCULAR fibres, whether they be ſubject to the will, or act independently of it, are ſtill of the ſame nature: their contractions are ſimilar in effect; and, therefore, to be attributed to ſimilar cauſes.

2. A muſcle, ſubject to the will, or what I ſhall call, for conveniency, a voluntary muſcle, cannot be made to act by volition, if the nerve by which that muſcle is connected to the brain, be cut; conſequently, the nerves perform an eſſential part in voluntary muſcles.

3. But, as contraction is an effect produced upon a muſcular fibre; and as the nerves are eſſentially neceſſary in producing that effect, in

voluntary muſcles; ſo they muſt alſo be eſſentially neceſſary to produce that effect in all fibres, whether voluntary, or involuntary.

4. The nerves, then, form an eſſential part in the conſtruction, and communicate a power, eſſentially neceſſary in producing the contraction of all muſcular fibres, whether voluntary, or involuntary.

5. If a man, in perfect health and vigour, be ſuddenly deprived of a large quantity of blood; although the brain and nerves, a moment before, were replete with power and animation; yet, upon that loſs of blood, the power of moving the muſcles will be loſt alſo.

If in an animal of any kind, in perfect health and vigour, the arteries ſupplying any muſcular part with blood, be cut, or tied; the power of moving that part, or muſcle, will be diminiſhed, though the brain and nerves are unaltered and unexhauſted. Conſequently, the preſence of blood is eſſentially neceſſary to the perfect action of muſcular fibres.

6. What is contraction?—In what does the contraction of a muſcular fibre conſiſt?—The fibre is ſhortened; its extremities are brought nearer together:—in fact, the particles of matter, of which the muſcular fibre is compoſed, are approximated; that is, they are attracted nearer to each other.

7. Muſcular contraction, then, is neither more nor leſs than this; the particles of matter, arranged ſo as to form a fibre, by the influence of the nerves, are attracted nearer to each other.

8. The component particles of a muſcular fibre, in their common, or inactive ſtate, are conſiderably diſtant from each other: the nerves impart a power, or powers, by which thoſe diſtant particles are attracted to each other; conſequently, their diſtance muſt be leſſened, and the fibre they form muſt become ſhorter.

9. But, as the particles compoſing muſcular fibres when not in action, are diſtant from each other; the power by which they are rendered attractive to each other muſt be extended from one particle to another; ſince nothing can act where it is not: conſequently, the power communicated by the nerves, muſt extend around the component particles of the muſcle, in an atmoſpheric ſtate; ſo, that the atmoſphere of one particle may be in contact with the atmoſphere of the next particle to it.

10. But, if a power forms itſelf into an atmoſphere around a particle of matter, it is evident, that it does not ſimply attract that particle ſo as to enter into cloſe combination with it; but, on the contrary, it merely arranges itſelf around it, in an atmoſpheric ſtate; therefore, it cannot be ſuppoſed that two ſimilar atmoſpheres, thus arranged, can attract each other.

11. It is well known, that the particles of the acid principle, when they acquire atmoſpheres, and become aeriform, are not attrac-

tive amongſt themſelves; on the contrary, the atmoſphere ſurrounding each acid particle, acts againſt, or reſiſts the approach of every ſimilar atmoſphere: and, as was before obſerved (ſect. ii. 14) the particles of the alkaline principle, when ſurrounded by the phlogiſtic power, are kept diſtinct and diſtant from each other; conſequently, thoſe atmoſpheres of phlogiſton do not attract each other, nor draw the alkaline particles together.

12. But it has been ſhewn, (ſect. ii. 14) that an atmoſphere of the æthereal power, ſurrounding the acid principle, will attract an atmoſphere of phlogiſtic power, around its antacid principle; and by that attraction they will draw their reſpective particles of acid and alkaline principles into contact; conſequently, by analogy we are led to ſuppoſe, that muſcular fibres are formed of particles of the material principles, ſimply connected together, by ſimple fibrils; and, that the nerves of the two kinds, convey the two contrary powers, to thoſe material particles in muſcular arrangement, each

power communicating with its alternate particles; which powers, when diſcharged from their reſpective nervous fibrillæ, aſſume an atmoſpheric ſtate around the muſcular particles; and, that thoſe contrary atmoſpheres of the æthereal and phlogiſtic powers attract each other, and the particles which they ſurround, into combination; by which means, the fibres formed by thoſe particles, muſt be rendered ſhorter, of courſe.

I therefore conclude—

1ſt. That every muſcular fibre is formed of particles of the material principles, in muſcular arrangement, connected together by ſimple fibres.

2d. That thoſe particles are alternately connected with the two kinds of nervous fibrillæ; every other particle being connected with the æthereal; and every intermediate particle with the phlogiſtic nervous fibrillæ, or the fibres which convey thoſe powers.

3d. That when the nerves are excited, they diſcharge their reſpective powers.

4th. That thoſe powers flow to, and ſurround their reſpective particles of matter, in muſcular arrangement ; and,

5th. That the æthereal and phlogiſtic powers, thus ſurrounding the alternate particles of the material principles in muſcular arrangement; by their mutual attraction to each other, draw their reſpective material particles into contact ; and, by that means, the fibre formed by thoſe particles is ſhortened ; and the æthereal and phlogiſtic powers being diſcharged, combine together, and conſtitute fire, or the heat which is produced in animals, by the functions of life.

It is not eaſy to conceive, however, how the æthereal and phlogiſtic powers, thus ſimply communicated to the particles of matter in muſcular arrangement, can form atmoſpheres around thoſe particles, ſo as to extend from one to the other; when in their common, or inactive ſtate, they muſt be conſiderably diſtant; becauſe, as the æthereal and phlogiſtic powers flow along the nerves, they cannot be in the ſtate of atmoſpheric arrangement.

If, then, the æthereal and phlogiſtic powers, when excited to flow along their reſpective nerves, are ſimply excited, but not atmoſpheric, it is natural to ſuppoſe, that when communicated to their reſpective particles, in muſcular arrangement, they will flow around them in ſtates of ſimple excitation, but not forming any extenſive atmoſpheres:—but, as thoſe particles in muſcular arrangement are diſtant from each other, ſome intermediate powers extending from one particle to another, muſt be neceſſary, to bring them together, and thoſe powers muſt be excited by the nervous powers.

It appears, then, that the nervous powers, when excited, excite other powers; and that thoſe powers draw the muſcular particles together by their attraction to each other.—But, before we proceed further, it may not be improper to conſider what attraction itſelf is; in what circumſtances it takes place; and what are the powers and conditions neceſſary to produce it.

SECTION V.

On attraction, and the powers by which it is produced.

1. ATTRACTION is the force, or power, drawing two or more bodies towards each other; or holding them together when in contact.

2. Attraction is an effect, produced by an adequate cauſe: nothing cannot be adequate to the removal of two bodies towards each other; therefore, whenever two diſtant bodies are attracted towards each other, it muſt be by an intermediate ſomething; poſſeſſing the power of moving them in thoſe directions.

3. Attraction implies, at leaſt, two bodies; but does it require that each ſubſtance ſhould

have its attractive power, or is one ſimple attractive principle ſufficient to explain attraction in all caſes? for, as attraction is a ſimple effect, it muſt have a ſimple cauſe; and the ſame effect, in whatever circumſtances it is produced, muſt be referred to the ſame cauſe.

4. Let us then attend to the power or powers by which attraction is produced, in its ſimpleſt and moſt evident ſtate; that is, the power which the magnet poſſeſſes of attracting iron.

5. A magnet poſſeſſes the power of attracting iron at a conſiderable diſtance:—this power is a ſomething in an atmoſpheric ſtate, which extends from the magnet, as its centre, to the iron; as is evident; becauſe it may be deſtroyed by fire, and reſtored again by another magnetic atmoſphere, or by the electric fluid.

6. If a needle be rendered magnetic, what is called its north pole will evidently attract iron at the diſtance of ſix inches; its con-

trary, or ſouth pole, alſo, will attract iron at the diſtance of ſix inches; conſequently, each pole of the needle has an atmoſphere of ſix inches extent from the magnet, and each of thoſe atmoſpheres attracts iron.

7. If another needle be rendered magnetic to an equal degree; its north, or ſouth pole, will, alſo, attract iron to the diſtance of ſix inches; that being the extent of thoſe atmoſpheres.

8. The two needles then have four poles; each ſurrounded with an atmoſphere, attractive to iron at the diſtance of ſix inches.—Are all theſe atmoſpheres the ſame fluid?—If ſo, they will all equally attract or repel each other; becauſe, the ſame cauſe muſt have the ſame effect, when all circumſtances are the ſame.

9. If we take the north poles of the two magnetic needles, and bring them towards each other, they will repel each the other at the diſtance of twelve inches:—then the atmo-

ſpheres of the two north poles, being ſimilar, repel each other;—in like manner, and at the ſame diſtance, the two atmoſpheres of the ſouth poles will repel each other.—It is evident then, that magnetic atmoſpheres, north or ſouth, will attract iron, and repel each other.

10. But—if the north pole of one magnetic needle be brought towards the ſouth pole of the other, they will attract each other, at the diſtance of twelve inches.—It is evident, from the preceding conſiderations, that ſimilar atmoſpheres repel each other:—it is evident, in this caſe, that the atmoſpheres of the north and ſouth pole attract each other: conſequently, they are not ſimilar atmoſpheres; nor can they be formed of the ſame principle, or power.

11. It is evident, then, inconteſtably ſo, that there are two diſtinct powers; that one of them, being excited to arrange itſelf in an atmoſpheric ſtate around one extremity of a needle, the other power arranges itſelf in a ſimilar manner around the oppoſite end; that either atmo-

ſphere will attract iron: that either atmoſphere will repel, or reſiſt, the approach of another atmoſphere, formed of the ſame principle, or power; but, that the two contrary principles will powerfully attract each other, and the needles which they ſurround, into contact, whenever the atmoſpheres formed by them are brought within each other's influence, or extent.

12. On a former occaſion, (ſect. ii. 14, &c.) when conſidering the nature of aeriform fluids, the concluſion was the ſame:—the atmoſpheres ſurrounding particles of the acid principle, and rendering them aeriform, are certainly formed of the ſame principle or power; and thoſe atmoſpheres as evidently repel each other. By repulſion, however, in this and every caſe, I mean no more than the reſiſtance which bodies, fluids, or powers, make againſt each other, when any external force is applied, tending to make them approach nearer than the point of ſimple contaction.

The atmoſpheres ſurrounding particles of the alkaline principle are ſimilar, and repel each other:

But, if an acid and alkaline gas be mixed together, their reſpective atmoſpheric powers will inſtantly attract each other; and drawing the acid and alkaline principles together, will leave them in combination, and diſappear.

It is evident, then, in this caſe, as in magnetiſm, that ſimilar atmoſpheres repel each other: that the atmoſpheres of the acid and alkali attract each other; therefore, they are not ſimilar; and, conſequently, it is evident, that particles of the acid principle are rendered aeriform, by means of a power of one kind, arranging itſelf in an atmoſpheric ſtate around each particle; that the particles of the alkaline, or antacid principle, are rendered aeriform by a power of another kind; that ſimilar atmoſpheres, or of the ſame power, in all caſes repel each other; but, that the atmoſpheres formed by one power, will, in proper circumſtances, attract and combine with the atmoſpheres formed by the other; and by that co-attraction of the two atmoſpheres, their reſpective baſes of acid and alkali are drawn into combination.

13. That the acid and alkaline particles themſelves can have any attractive influence upon each other in the aeriform ſtate, is impoſſible.

A pint of pure air, formed of the acid principle rendered aeriform, weighs, in the common atmoſphere and temperature, about nine grains; —a pint of nitrous acid itſelf, weighs about nine thouſand grains;—a particle of the acid principle then, in an aeriform ſtate, occupies a ſpace one thouſand times greater than when it is in its acid ſtate.

The power, therefore, which conſtitutes the atmoſphere of a particle of the acid principle, and renders it aeriform, is one thouſand times more extenſive, than the particle of acid itſelf is; and, therefore, nothing can touch or act upon that central particle of acid, without firſt of all removing, deſtroying, or paſſing through this atmoſphere, ſo much more extenſive than the ſpace occupied by the particle of acid itſelf.

When a particle of the contrary, or alkaline principle, is in a ſimilar, or aeriform ſtate, it muſt be ſurrounded by an atmoſphere of at leaſt equal extent; therefore, a particle of the alkaline principle muſt be rendered aeriform, by being ſurrounded by an atmoſphere, occupying a ſpace one thouſand times greater, than what the particle of alkali itſelf occupies: conſequently, it cannot be poſſible that the acid and alkaline particles, in the centres of thoſe widely-extended atmoſpheres, can attract each other; or can be brought into contact, but by the mediation of thoſe very atmoſpheres themſelves, attracting each other, and drawing their reſpective centres together.

14. The united powers of mechaniſm can-

not make two atmoſpheres of the ſame power combine :—they may be compreſſed, diſplaced, or deranged, by extra force; but the inſtant that the external force is removed, the powers reſume their uſual ſtate of arrangement; and this power of arrangement it is which conſtitutes elaſticity.

15. Let us now attend to electric attraction.—If a globe of glaſs be connected to an inſulated conductor; if an inſulated rubber be alſo connected to an inſulated conductor, and the rubber be made to excite the globe, an electric atmoſphere will flow from the globe to its conductor; and at the ſame time, an electric atmoſphere will flow from the rubber to its conductor alſo.

If two light bodies, ſuſpended by non-conducting filaments, be brought to the conductor of the globe, each will receive an atmoſphere of electric fluid; and the two atmoſpheres will repel each other.

If two light bodies, in like manner, be applied to the conductor of the rubber, each will receive an atmoſphere, and the atmoſpheres will repel each other;—ſimilar electric atmoſpheres, therefore, invariably repel each other.

If one light body, having obtained its electric atmoſphere from the globe, be brought near to another, whoſe electric atmoſphere was acquired from the rubber; the two atmoſpheres will attract each other; will draw the two light bodies together; and will combine and diſappear:—theſe two atmoſpheres, then, attract each other:—ſimilar atmoſpheres repel each other; — theſe, then, are not ſimilar atmoſpheres:—that is, they are formed of different principles, or powers; and, as was found to be the caſe with magnetic atmoſpheres, and aeriform fluids, atmoſpheres, formed of the ſame power, repel each other; but, an atmoſphere formed of one power, will attract and combine with an atmoſphere formed by the other, or contrary power.

16. I aſſume, therefore, as an inconteſtable fact, that there are two diſtinct powers in nature; which are capable of forming different degrees and modes of connexion with the principles of matter; that when either power is excited by its connexion with matter, it has no attraction to the ſame power, in a ſimilar ſtate of excitement with other portions of ſimilar matter; but, when the two powers are in ſimilar ſtates of connexion with their reſpective material principles, and in ſimilar ſtates of excitement, that thoſe two contrary powers will attract each other; and, conſequently, that power of mutual attraction will be exerted upon the particles of matter which each is connected with; and will draw, or tend to draw them together.

17. As attraction is, in all caſes, the ſame effect, it muſt, in all caſes, be produced by the ſame cauſe: theſe two diſtinct powers, then, by connexion with the acid and alkaline principles, become attractive to each other; and by

their mutual co-action it is, that every attraction in nature is performed.

18. I have, on a former occaſion, (ſect. ii. 17.) given the name of the æthereal power, to that power which is excited to arrangement by the acid principle; and that power which is excited to arrangement by the antacid, or alkaline principle, I have called the phlogiſtic power; and by theſe names I ſhall continue to diſtinguiſh them.

19. The æthereal and phlogiſtic powers, then, by their affinities with matter, and attraction to each other, produce all the attractions, whether chemical, magnetic, or electric; and even the attraction which connects worlds with worlds, and ſyſtems of worlds with other ſyſtems, ſo as to form a whole—an univerſe!—as wonderful as it is extenſive!—!—!

Theſe two powers are univerſally diffuſed, and preſent in every part.

They are excited by their reſpective material principles, and receive different degrees and kinds of excitement, as thoſe material principles happen to be differently circumſtanced, and combined with them, and with each other.

They conſtitute the atmoſpheres which render particles of the acid, or alkaline principle aeriform; they form the magnetic and electric atmoſpheres:—ſimilar atmoſpheres of the ſame power always repel, or reſiſt each other's approach.

Æthereal and phlogiſtic atmoſpheres, in ſimilar ſtates, attract each other, and their reſpective material principles; and when the æthereal and phlogiſtic powers combine, in a ſtate of excitement, and become diſengaged from matter, they conſtitute a new compound, which is Fire;—and that fire, acting upon them in their common ſtate of univerſal diffuſion, frequently imparts to them that motion and excitement which we call light.

20. Aerial, magnetic, and electric atmoſpheres, therefore, are formed of the æthereal and phlogiſtic powers, when excited to atmoſpheric arrangement by the acid and antacid principles, in different ſtates and combinations: the univerſal attraction which connects worlds into ſyſtems, and ſyſtems into an univerſe, is effected by the ſame two powers, equally and univerſally diffuſed, as far as creation extends; in which ſtate of univerſality, worlds are their exciting centres.

Light itſelf is no other than an impulſive excitement communicated to thoſe two powers, in their ſtate of univerſal diffuſion; and fire is produced, whenever thoſe two powers, excited by connexion with the material principles, combine together, in that excited ſtate, and recover their freedom; by the particles of matter they draw together, attracting each other to combination.

21. That all theſe kinds of attraction are performed by the ſame two powers, is abun-

dantly evident, from a thouſand circumſtances.

The æthereal and phlogiſtic powers in an aerial ſtate, by combination give light; ſo do electric atmoſpheres, and ſo does fire.

Light, by reſiſtance, forms fire: aerial atmoſpheres by combination form fire; ſo do electric atmoſpheres.

Light, fire, or electric atmoſpheres, impart to the alkaline principle the phlogiſtic power; and render its particles aeriform, or inflammable air; and they alſo convert the particles of the acid principle into pure air, by ſupplying them with the æthereal power.

Magnetic atmoſpheres are deſtructible by fire, or by electric powers; and iron may be rendered magnetic by the phlogiſtic and æthereal powers in an electric ſtate; and, in all caſes, if iron be deprived of its phlogiſtic power, it is rendered incapable of exciting the æthereal and phlogiſtic powers to magnetic arrangement.

22. In ſhort, all atmoſpheres, whether aerial, magnetic, or electric, with their general properties and laws of action, are inexplicable, by the utmoſt efforts of ingenuity, if two powers are not admitted, as producing thoſe different atmoſpheres, by each being excited in a ſtate of ſeparation from the other.—Attraction can only be explained by their coaction, and coincidence; fire by their combination; and light by an impulſive excitement communicated to them in their common ſtate of univerſal diffuſion.

That the ſame two powers, (the æthereal and phlogiſtic powers,) aſſume all theſe ſtates, and produce all theſe effects, is evident, from the convertibility of one ſtate into another, mutually and reciprocally; from the reſemblance that all atmoſpheric arrangements have to each other; from the repulſion which takes place in every kind of atmoſpheric arrangement between ſimilar atmoſpheres, whether æthereal or phlogiſtic; from the attractive force which is always produced when the two contrary powers combine, whatever be their peculiar ſtate of excitement; from the fire which they commonly form by combination; from the excitement which that fire commonly gives to light; and from the facility with which light may be converted into fire.

23. From the preceding conſiderations I draw the following concluſions:

1ſt. That an æthereal and a phlogiſtic power exiſt, univerſally.

2d. That the æthereal power is capable of being excited to atmoſpheric arrangement by the acid principle; and, the phlogiſtic power by the alkaline principle.

3d. That thoſe principles of matter, in different ſtates of combination and activity, impart different kinds or degrees of excitement, to the æthereal and phlogiſtic powers.

4th. That two atmoſpheres of the ſame power, in ſimilar ſtates of excitement, conſtantly and mutually repel each other.

5th. That an atmoſphere of the æthereal power, will mutually attract and be attracted by an atmoſphere of the phlogiſtic power, in a ſimilar ſtate of excitement.

6th. That the effect of that mutual attraction is combination; by which the particles of matter thoſe atmoſpheres ſurround are drawn together, if not counteracted by a ſuperior power.

7th. That the æthereal and phlogiſtic powers by uniting in this ſtate of excitement form fire, when diſengaged by the combination of their reſpective material principles with each other.

8th. That light is a progreſſive excitement imparted to the æthereal and phlogiſtic powers in their common ſtate of general and univerſal diffuſion ;—and

9th. That in that ſtate of general diffuſion, they are excited by worlds, and ſyſtems of worlds, to bind the whole into one grand univerſe; in which their attractive powers are ſo moderated by diſtance, as juſt to counteract the rectilinear tendency of motion; by which a whole is produced ; in which every part is regular in its motion, and undeviating in its circuitous path !

I have ſo frequently conſidered this ſubject in my former tracts, and in ſo extenſive a manner, that I neither think it neceſſary, not feel myſelf diſpoſed to enlarge upon it in this place. There are, however, ſome peculiarities attending theſe two attractive powers, which are too eſſential to be overlooked ; theſe are the ſimultaneous production of ſimilar excitements in the two contrary powers by ſeparation : the power which ſimple atmoſpheres have of exciting ſecondary or external atmoſpheres; and, the reciprocal changes which take place between the powers of attraction and arrangement; which will therefore be conſidered in the following ſection.

SECTION VI.

On the general laws by which the æthereal and phlogiſtic powers are regulated, in their operations with the material principles, and with each other.

LAW I.

THE excitation of the æthereal and phlogiſtic powers is ſimultaneous.

1. The phlogiſtic and æthereal powers, as already obſerved, (ſect. v. 19.) are univerſally extended; and, conſequently always preſent in their common ſtate of general diffuſion. In that ſtate they have the ſimple excitement of general attraction, by which diſtant maſſes of matter are connected together; conſequently the æthereal and phlogiſtic powers in that ſtate of general excitement attract each other.

2. Whenever iron becomes *magnetic* it invariably acquires two atmoſpheres; one at each extremity: the atmoſphere at the north pole, or at the ſouth pole, repels every ſimilar atmoſphere; but the atmoſphere of the north will powerfully attract that of the ſouth pole of another magnet; conſequently, as before obſerved, (ſect. v. 10.) the two contrary atmoſpheres are formed of two diſtinct powers. But, whenever one atmoſphere is excited, the other appears at the ſame time, invariably.

3. It appears, then, that whenever the two powers in their common ſtate receive an excitement of a more powerful kind, they will aſſume a new ſtate: but, it appears equally evident, that the new ſtate of excitement conſiſts in ſeparation, as well as excitement; for neither power can aſſume the ſtate of magnetic excitement, at one extremity of a needle; unleſs the other power aſſumes a ſimilar ſtate at the other extremity.

4. It appears probable, then, that the æthe-

real and phlogiſtic powers, when combined, are inactive with reſpect to other matters; that when they are ſeparated they are active, and aſſume the atmoſpheric arrangement, and retain that activity till they can again combine; by which combination they draw the material principles with which they are connected, together; which conſtitutes attraction.

5. That this is probable from the conſideration of magnetic atmoſpheres, is evident; and that it is a general law will appear evident from the following obſervations:

6. Whenever *electric* appearances are excited by an electric ſubſtance and its rubber, it is univerſally known, that two atmoſpheres are invariably produced. If the apparatus be properly adapted for the purpoſe, one atmoſphere will flow from the electric to its conductor; and another, at the ſame time, will flow to a conductor connected with the rubber. Theſe atmoſpheres are at all times and in all caſes ſimultaneous.

It has been already ſaid, (ſect. v. 15, &c.) that theſe atmoſpheres are neceſſarily formed of two powers; becauſe, like all other æthereal and phlogiſtic atmoſpheres, ſimilar atmoſpheres repel each other invariably; but, an atmoſphere from the electric, as conſtantly attracts an atmoſphere from the rubber.

7. It is evident, then, that the phenomena of electricity depend upon the æthereal and phlogiſtic powers being excited and ſeparated from each other; conſequently, each aſſumes the ſtate of electric arrangement at the ſame inſtant; and they remain in thoſe ſtates of electric atmoſpheres till they have an opportunity of combining; to effect which combination they draw their reſpective centres together, if nothing prevents, and by uniting loſe the electric properties they had while in a ſtate of ſeparation.

8. Whenever either of the two powers, æther and phlogiſton, is *chemically* excited and ſeparated from the other, that other at the ſame time, becomes equally active, and acquires che-

mical properties and affinities. Thus, nitrous acid conſiſts of the antacid principle, with an exceſs of the acid principle. If it be expoſed to the influence of the æthereal and phlogiſtic powers in the ſtate of light, the acid particles will attract the æthereal power, and excite it to arrangement around them, by which they will be rendered aeriform and conſtitute pure air; and, at the ſame inſtant, the antacid particles will attract the phlogiſtic power and acquire a change of colour and properties. Theſe antacid particles do not, indeed, become aeriform with their phlogiſton, becauſe there is an exceſs of acid ſtill remaining to detain them in combination.

So, alſo, when calces of gold, ſilver, mercury, &c. are expoſed to the action of fire, light, or electric powers, when the earthy baſis of the metal acquires the phlogiſtic power, which reſtores it to its metallic luſtre and properties, the acid particles which were combined with it in the ſtate of calx, combine with the æthereal power, invariably; ſo that both the æthereal and phlogiſtic powers acquire the excitement of chemical affinities at the ſame time.

9. It is evident, then, that when the æthereal and phlogiſtic powers are ſeparated from a ſtate of ſimple combination with each other, whatever degree or kind of excitement is imparted to the one, the other, by the ſame means, becomes equally and ſimilarly excited; whether it be the magnetic, electric, or chemical arrangement and attraction which they are excited to.

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LAW II.

WHEN the æthereal and phlogiſtic powers are ſeparated and ſimultaneouſly excited, they are capable of imparting a ſecondary excitement to the common powers ſurrounding them.

1. When the æthereal and phlogiſtic powers are excited to form *electric* atmoſpheres; thoſe atmoſpheres will diffuſe themſelves upon the ſurface of a conducting body.

2. Thoſe atmoſpheres are of ſmall extent, as is evident from this, that the two contrary atmoſpheres require to be brought very near each other before they can combine and diſappear; and though they eaſily ſpread upon any conducting ſurface, they cannot communicate themſelves from one body to another, unleſs thoſe bodies approach very near to each other; conſequently, the true electric atmoſphere is of ſmall extent from the ſurface it ſurrounds.

3. If a conductor be rendered electric by a phlogiſtic atmoſphere, although that atmoſphere will not combine with its contrary or æthereal atmoſphere whoſe conductor is at the diſtance of an inch, and conſequently that atmoſphere is not extended half an inch from the ſurface of its conductor; yet it will attract a light body at the diſtance of many inches:—it muſt, therefore, have a ſecondary atmoſphere of ſeveral inches extent, beyond the primary electric one.

4. This, however, is not properly the electric atmoſphere, becauſe it is incommunicable by it-

ſelf; a light ſmall body may be attracted by it, and completely immerſed in it, and may ſtill be withdrawn without any electric communication; it is only when the body has been in contact with the real, primary, electric atmoſphere, that it acquires a portion of that electric atmoſphere, and then is repelled; according to the general law, that ſimilar atmoſpheres repel each other.

5. If two conductors, one having an electric atmoſphere of the æthereal, and the other of the phlogiſtic power, be placed twelve inches from each other, thoſe two contrary powers cannot combine, becauſe they are not in contact.

If a light body be brought between them, it will be attracted by that atmoſphere to whoſe influence it is moſt expoſed; it will be drawn to the ſurface of the conductor, till it arrives at the primary atmoſphere itſelf; it will then be charged, repelled, and attracted to the other conductor; where it will be diſcharged, re-electrified with the contrary electric power, and repelled; and ſo on, in repeated alternations; till it has diſcharged the atmoſphere of each, by conveying it to combine with the other; and till the repulſion of one, cannot propel the intervening body within the attractive atmoſphere of the other.

6. It is evident, then, that the two electric atmoſpheres of æthereal and phlogiſtic powers, though of ſmall extent themſelves, have ſecondary or external atmoſpheres which communicate from one to the other, or extend around each to a great diſtance.

It is evident, that each power has its diſtinct ſecondary atmoſphere; becauſe each conductor will attract a light body to itſelf, at a conſiderable diſtance.

It is evident that the ſecondary atmoſphere of each power in an electric ſtate, is different from the ſecondary atmoſphere of the other; becauſe two bodies with ſimilar electric and ſecondary atmoſpheres, repel each other to the extent of thoſe ſecondary atmoſpheres; and, an external or ſecondary atmoſphere ſurrounding the conductor of the electric, will attract the ſecondary atmoſphere ſurrounding the conductor of the rubber, ſo ſoon as thoſe ſecondary atmoſpheres are in contact; and at a much greater diſtance, than that where the primary electric atmoſpheres came in contact and combine.

7. It is impoſſible, then, to deny, with any ſupport from reaſon, that every body in an electric ſtate, has a primary and ſecondary atmoſphere ſurrounding it: the ſecondary or external atmoſphere, will attract all bodies within its extent; but it is incommunicable, unleſs the body it attracts be brought in contact with the primary atmoſphere; in which caſe, a portion of that primary atmoſphere will diffuſe itſelf to the approaching body, and with it a portion of the ſecondary atmoſphere alſo; by which the body will be repelled, as having an electric atmoſphere, ſimilar in its principles to that of the body from which it was communicated.

8. It is evident, then, when the æthereal and phlogiſtic powers are ſeparated and excited to

the electric ſtate, that each will flow along conducting ſurfaces near them :—that in thoſe ſtates of electric excitement they are extended to a ſmall diſtance from the conducting ſurface ; and that each will communicate a certain degree of excitement to the contrary powers preſent in their ſtate of univerſal diffuſion.

9. When the æthereal power is rendered electric, it will excite the phlogiſtic power in common diffuſion, to form a ſecondary atmoſphere around it ; at the ſame time, the phlogiſtic power being rendered equally electric, will excite a ſecondary, or external atmoſphere of the commonly diffuſed æthereal power around it : ſo that the æthereal and phlogiſtic powers, when ſeparated and rendered electric, give a peculiar excitement to the powers in the common ſtate of diffuſion, by which they become ſeparated, and form ſecondary atmoſpheres attractive to each other and to matter in general.

Each external atmoſphere attracts the other ; each will attract bodies within its extent, to its reſpective centre; each of them will ſurround another body to which a portion of its primary exciting atmoſphere has been communicated by contaction: each of them will repel a ſimilar atmoſphere, thus communicated to another body; but, neither of them can paſs to any other body, to which its exciting primary atmoſphere has not been communicated; neither can the two external atmoſpheres though formed of the contrary powers, and powerfully attractive to each other, combine, and return to their common ſtate of diffuſion, till their reſpective primary atmoſpheres by coming into contact, deſtroy each others electric properties and arrangement; in which caſe, both primary and ſecondary atmoſpheres will combine and return to their equal ſtate of general diffuſion.

10. That the æthereal and phlogiſtic powers, when excited to electric arrangement, in ſtates of ſeparation, have the power of exciting the ſurrounding powers in their common ſtate, ſo as to form ſecondary or external atmoſpheres around the ſeparated powers in the electric ſtate, is abundantly evident, from what I have now ad-

vanced; and particularly from the more minute diſcuſſions of the ſubject, which I have laid before the public upon various occaſions; and that theſe powers in other ſtates of excitement have ſimilar effects upon the common powers is undeniable.

11. *Magnetiſm* is peculiar to iron.—If iron be deprived of its phlogiſton, it loſes its power of becoming magnetic. The magnetic atmoſpheres are, to a certainty, formed of contrary and diſtinct powers in arrangement: that extremity of a needle which is now pointing to the north, may, by the proper application of a magnet, be made to point to the ſouth: conſequently, either extremity of a needle is equally well adapted to become the centre of either of the magnetic powers in arrangement; and, therefore, the needle is formed of certain principles which are capable of exciting either of the powers to magnetic arrangement; and which principle becomes excited at either extremity, depends entirely upon the circumſtances which produce that excitement.

12. The needle, then, throughout its whole extent, is equally attractive to the phlogiſtic and æthereal powers; and it only becomes magnetic when its phlogiſtic power is peculiarly excited towards one extremity; and its æthereal power to the other, as a conſtant and invariable conſequence.

13. The needle, then, in its natural ſtate, contains a certain proportion of the æthereal and phlogiſtic powers, attracted within its ſubſtance by its component particles.

When it is excited that æther and phlogiſton are ſeparated; and the phlogiſtic power is attracted by the particles of the iron at one end of the needle and the æthereal power at the other.

The æthereal and phlogiſtic powers are then excited by ſeparation and by being attracted by the particles of iron conſtituting the needle. The needle does not contain more æthereal and phlogiſtic power when magnetic, than in its natural ſtate; only, thoſe powers are ſeparated;

one being drawn towards one extremity, the other towards the contrary.

The powers thus excited, then, are ſimply diffuſed within the ſubſtance of the iron; and are attracted and excited by every individual particle compoſing that needle; in conſequence of which, they are not diffuſible like the electric powers, which are ſimply excited on the ſurfaces of bodies.

In this ſtate of excitement, then, in which the æthereal and phlogiſtic powers are ſimply diffuſed through the iron and excited by its particles, individually, each power excites its ſecondary atmoſphere; the æthereal power collected and excited at one extremity of the needle, excites the phlogiſton of the common powers, univerſally diffuſed; and the phlogiſtic power at the other extremity of the needle, excites its ſecondary atmoſphere of the æthereal power, in the common ſtate of diffuſion: theſe ſecondary atmoſpheres are extended around each pole; each will attract iron; ſimilar atmoſpheres will repel;

and the two contrary powers will powerfully attract each other. When a bar of iron has been attracted to one pole of a magnet, it cannot be repelled; becauſe the primary magnetic power is not diffuſible; being ſimply excited within the very ſubſtance of the iron, by which it is naturally attracted in a peculiar manner, and from which it is inſeparable; but, on the contrary, it will be attracted and detained, becauſe its own powers are excited to a magnetic ſtate; the phlogiſtic power of the magnetic needle will attract the æthereal power of the iron bar, or needle, to that extremity in contact with it; and its phlogiſtic power will, in conſequence, become equally excited at the diſtant extremity; in conſequence of which, when removed, it will be found to be in a magnetic ſtate alſo: only, that end which was in contact with the æthereal end of the magnet, will be phlogiſtic; and the contrary end will have the æthereal power in magnetic excitement; and thoſe powers, thus ſeparated within the needle, or bar of iron, will each excite a ſecondary atmoſphere around them, attractive to iron and to each other, as in the needle by which it was excited.

14. In *chemical* excitement the æthereal and phlogiſtic powers are equally ſubject to the influence of this law.

We know that the acid and alkaline principles will powerfully be attracted and combined if brought together: attraction, in all caſes, is produced by the ſame cauſe; that cauſe is the mutual co-action, and progreſſive coaleſcence of the æthereal and phlogiſtic powers, in ſimilar ſtates of excitement; the acid and alkaline principles, therefore, in their pureſt, ſimpleſt, or moſt powerful and condenſed ſtates, have *each* its reſpective *power* chemically excited around it to a ſmall extent; and thoſe powers by mutual attraction, draw their reſpective principles into combination, and detain them there.

If theſe two principles be ſeparated, the power chemically excited by each principle, will, then, attract a *ſecondary* or *external* atmoſphere, and aſſume the aeriform ſtate; unleſs one or both be ſtill detained, or attracted by other principles in a more condenſed ſtate.

Thus nitrous acid, when ſeparated from its combination with the antacid, or alkaline principle in various ſtates, and by various operations, excites an external or ſecondary atmoſphere, and forms, by that means, pure air; and inflammable air is in many operations produced, when the alkaline principle is ſeparated from the acid principle, and excites an external atmoſphere of the phlogiſtic power. The calx of mercury is reduced in cloſe veſſels, by a degree of heat ſufficient to remove the particles of the antacid principle, or earth of the mercury, from the acid principle, ſo as to deſtroy their attraction, by ſeparating them beyond each others extent; in which caſe, the acid particles excite an æthereal atmoſphere, and form pure air; while the antacid particles of the mercury excite the phlogiſtic power; which they attract in ſuch proportion as to reſtore them to their metallic ſtate of pure mercury.

It is in numberleſs inſtances evident, that the two material principles are capable of aſſuming various ſtates; ſometimes being condenſed into the ſtates of powerful acids, or alkalies; at others being expanded into aeriform fluids; and frequently being in various intermediate ſtates, as they happen to be combined together, in greater or leſs proportions: it is evident, therefore, that theſe principles, at ſome times, poſſeſs the powers in ſtates of ſimple chemical excitement; and at others, that they acquire extenſive atmoſpheres and expand into air; in which ſtate, the different principles are ſeparated and rendered individually aeriform. Conſequently, it is reaſonable to ſuppoſe, that when the æthereal and phlogiſtic powers are *chemically* excited, they form atmoſpheres of ſmall extent around their reſpective material principles, attracting them together; but if they be ſeparated, each power, at the ſame time, excites a *ſecondary* atmoſphere around it, to a conſiderable extent, by ſeparating and attracting the common powers, at all times preſent; by which, each principle will be rendered aeriform, unleſs circumſtances forbid.

15. I have entered minutely and largely upon this ſubject in my Elementary Principles of Nature; and have given my reaſons for concluding, that the ſimple particles of matter are homogeneous: that every particle of matter is connected with and ſurrounded by an atmoſphere of one, or other of the powers, of ſmall extent:—that a particle of matter with an atmoſphere of æthereal power, in chemical excitement, forms a particle of the alkaline principle; that particles of matter with atmoſpheres of *phlogiſton*, chemically excited, form the acid principle; that the acid and alkaline principles thus formed mutually attract each other to chemical combination; and, that if they be ſeparated from combination with each other, each particle, then, excites a ſecondary atmoſphere of conſiderable extent; which, if not interrupted, renders the two material principles aeriform. In theſe ſtates, ſimilar atmoſpheres repel; and the contrary powers, or atmoſpheres, mutually attract each other to combination.

16. I think it allowable, then, to conclude, when the æthereal and phlogiſtic powers are

excited, by contact with matter, to aſſume either electric, magnetic, or chemical arrangements and properties, that they form, ſimply excited atmoſpheres, of *ſmall* extent; differing in the different kinds of excitement: that thoſe ſimple atmoſpheres of the two kinds, whether electric, magnetic, or chemical, are attractive to each other; that if they be ſeparated ſo as to be no longer within each others influence, each power, whatever be its ſtate of excitement, immediately excites a *ſecondary atmoſphere*, of much *greater* extent around it; that ſimilar atmoſpheres of the ſame power, in all caſes, repel; and the contrary powers in ſimilar ſtates of excitement, are attractive to each other.

LAW III.

THE æthereal and phlogiſtic powers when ſeparated and excited by the contact and influence of material principles, acquire two tendencies or properties; each power is excited to arrangement around its re-

ſpective material principle, and at the ſame time each is excited to be attractive to the other. Theſe properties reciprocate with each other; ſo that as the contrary material principles attract each other to combination, their attraction to their reſpective powers in arrangement diminiſhes or ceaſes; and as the material principles become ſeparated from each other, they exert their attractive influence upon their reſpective powers which they take into arrangement; which arrangement is more or leſs perfect and extenſive as thoſe material principles are more or leſs perfectly ſeparated from each other.

1. When the æthereal and phlogiſtic powers are excited to the *electric* ſtate, they ſimply attract the electric ſurface to the rubber: the inſtant that thoſe contiguous ſurfaces of the excited electric and rubber, are ſeparated, the ſimple electric atmoſpheres are *ſeparated* alſo; and then each excites its *ſecondary* atmoſphere to extenſive arrangement around it. If thoſe ſecondary or external atmoſpheres are permitted to draw their repective internal atmoſpheres into contact, ſo ſoon as thoſe primary atmoſpheres

attract each other into combination, the excitement of arrangement ceaſes; and the two external atmoſpheres return to their common ſtate.

2. It is evident, then, that when the combination of the primary electric powers is deſtroyed by ſeparation, each power exerts its property of arrangement, and acquires an external, extenſive atmoſphere; and that when thoſe primary atmoſpheres can again combine, their properties of exciting the arrangement of atmoſpheres around them ceaſe, and thoſe atmoſpheres become diſengaged.

3. As the æthereal and phlogiſtic powers in the electric ſtate of excitement, form merely ſuperficial, diffuſible atmoſpheres, it is evident that in thoſe ſtates they have no peculiar attraction, confining them to the ſurfaces they ſurround; when, therefore, the two powers, forming thoſe primary ſuperficial atmoſpheres, combine, they deſtroy each others electric properties, and atmoſpheric arrangement; and with

their ſecondary atmoſpheres return to their uſual mode of exiſtence.

4. In *magnetiſm* the ſame law prevails. Iron ſtrongly and peculiarly attracts both the æthereal and phlogiſtic powers, and they each other:—in this ſtate of combination, they have *no* atmoſpheres. If the æther and phlogiſton be *ſeparated* by magnetic excitement, the moment that their attraction of combination ceaſes to operate, their attraction of arrangement takes place, and each power acquires an extenſive atmoſphere: and the inſtant that the æthereal and phlogiſtic powers in the magnetic ſtate of excitement in the iron, combine and return to their uſual or natural ſtate of equal diffuſion through the iron by that combination, their powers of arrangement and of exciting external atmoſpheres ceaſe.

5. Magnetic atmoſpheres are not diffuſible like the electric, becauſe the primary atmoſpheres of the æthereal and phlogiſtic powers are excited by the attraction of the particles of the iron to thoſe powers in a ſtate of ſeparation;

thoſe primary magnetic atmoſpheres, therefore, cannot remove from their reſpective particles of the iron, neither can they combine together in any other manner, than by attracting and mutually being attracted together, in a ſtate of equal diffuſion throughout the ſubſtance of the iron; they are eſſential to the iron; they never leave it; they are always attracted by it either ſingly or combined; and it is only when *ſeparated* that they acquire the power of exciting *external* arrangements, of the powers, in the ſtates of magnetic atmoſpheres; but their power of exciting the contrary powers to external arrangement *ceaſes*, the inſtant that they can *combine* and return to their uſual ſtate in the iron.

6. In *chemical* excitements of the æthereal and phlogiſtic powers this law conſtantly is obſerved. The acid and antacid principles are attractive to each other, by which attraction they will *combine* in a ſtate of neutrality: but, whenever they are *ſeparated*, the acid principle will immediately excite the *æthereal* power, which is always preſent in ſome ſtate or other, to at-

moſpheric *arrangement*; and at the ſame time the antacid principle will excite the phlogiſtic power.

7. As chemical excitement is produced by the particles of matter in their pure ſtate, in contact with either the æthereal or phlogiſtic power, that ſtate of excitement and combination cannot be deſtroyed; for as matter in different ſtates enables the two powers to aſſume different degrees and kinds of excitement, it is reaſonable to ſuppoſe, that when ſimple matter and either of the two powers are immediately in contact, they will produce an excitement, which nothing can overpower; and, conſequently, which cannot be deſtroyed.

8. Matter with the æthereal and the phlogiſtic powers, ſingly, in chemical combination or excitement, thus conſtitutes the two unalterable principles, of acidity and alkalinity:—theſe will powerfully attract each other to combination; but, if they be ſeparated, the acid principle will excite the æthereal power to arrangement around it; and

the alkaline principle will acquire the property of exciting phlogiſton to arrangement around it.

9. When the æthereal and phlogiſtic powers in ſimple chemical excitement, by contact with matter, are combined with each other, perfectly, they have no power of attracting other powers to ſecondary arrangement. If they be ſeparated, the property of exciting the other powers to arrangement, ſingly, around them, inſtantly takes place: but, if the two principles again be brought into perfect combination, the power of exciting external atmoſpheres ceaſes; and the ſecondary atmoſphere ſurrounding each principle, will become diſengaged, and will therefore combine with the other. For example, either the acid or the alkaline principle, if they be in a ſtate of ſeparation, will attract an atmoſphere of the contrary power, and become aeriform: but, if the acid and alkaline airs be mixed together, thoſe atmoſpheres will draw the acid and alkaline principles together: when thoſe principles combine, they no longer can excite, or attract their re-

pective powers in arrangement, which therefore ecome diſengaged, and no longer atmoſpheric.

10. The acid and alkaline principles, then, have a ſtrong attraction for each other; but, if they are prevented from combining, or are ſeparated, they will attract their reſpective powers into atmoſpheric arrangement: ſo that each material principle has *two* modes of becoming ſaturated; the firſt is by *combination*, with its contrary material principle; and the ſecond is, by exciting the contrary power, or the power to which each has an affinity, to aſſume the *atmoſpheric arrangement* around it.

11. But, as the attraction of combination diminiſhes, the power of exciting atmoſpheric arrangement gradually increaſes; for if a rod of iron be once paſſed over by either pole of a magnet, the natural principles of the iron will be imperfectly ſeparated, and they will excite a ſecondary atmoſphere of *ſmall* extent; but, if by repeatedly drawing the magnet over the iron, the native powers of the iron be com-

pletely ſeparated, each power will then excite an *extenſive* atmoſphere around it.

So alſo in electricity; if the common powers be imperfectly excited and ſeparated, they will excite ſecondary atmoſpheres of ſmall extent; but, if by continued friction between the electric and its rubber, the two powers be entirely ſeparated, each will excite its ſecondary atmoſphere to an extenſive arrangement around it.

The ſame law being univerſal, muſt take place in every kind of excitement of the two powers; conſequently, in the chemical excitement, it is ſufficiently evident; for when the acid principle is diſengaged from the alkaline principle, it excites the æthereal power to form a complete atmoſphere around it, by which it is converted into *pure air*; if it be ſlightly attracted to combination by the antacid principle, which is not in a ſtate, or in ſufficient quantity to perfectly combine with it, its æthereal arrangement will be diminiſhed, as in *fixed air*; and, if it be more intimately attracted to combination by the antacid principle, which ſtill is not in a ſtate or proportion to perfectly combine with it, it will retain a ſtill leſs proportion of its æthereal arrangement and conſtitute an *acid* in a ſtate of liquidity.

12. In fact, the alkaline and acid principles, with their reſpective æthereal or phlogiſtic powers, may be combined in ten thouſand various ſtates and proportions; in conſequence of theſe properties of combination and arrangement of the æthereal and phlogiſtic powers, when chemically excited by matter, being *reciprocal*, one *diminiſhing* in power as the other *increaſes*. And the chief agent by which the material principles are ſeparated, when combined by chemical attraction, is fire; concerning which a few words may not be improper.

ON FIRE.

LAW IV.

WHEN the æthereal and phlogiſtic powers are excited to ſecondary arrangement, by the influence of matter, and in that ſtate of excitement, combine, and in that excited ſtate of combination become diſengaged, from matter, they will retain the power of, or the tendency to, arrangement around matter; and will, thereby, inſinuate themſelves into the atmoſpheres of any bodies near them.

1. We know nothing of the æthereal and phlogiſtic *powers*, but when they are connected with matter.—Unconnected and unexcited by matter, they are perfectly unknown to us; and it is only when excited by matter, that they become poſſeſſed of ſenſible powers and activity.

2. We know that the material principles have the power of exciting thoſe powers to arrangement;—and we know that the æthereal power in arrangement will attract the phlogiſtic power in a ſimilar ſtate.

3. If a particle of the acid principle with an æthereal atmoſphere, be brought near to a particle of the antacid principle with a phlogiſtic atmoſphere, the two powers will attract each other by combining; and they will alſo powerfully attract their reſpective material principles, ſo as to draw them into contact; conſequently, the æthereal and phlogiſtic powers when excited to *attract each other*, are alſo *attractive* to the *material principles.*

4. The two powers, then, when excited by matter, are excited to arrangement around it: while they remain in arrangement, they are attractive to each other: being ſeparated from matter, and retaining their excitement, they eagerly ſeek for matter around which they may arrange themſelves; therefore, when the æthe-

real and phlogiſtic powers are chemically excited by matter, and combine and become diſengaged from that matter, in that excited ſtate, they have a powerful tendency to *reſume* their atmoſpheric ſtate around matter.

5. When the æthereal and phlogiſtic powers are ſeparately expoſed to the influence of the material principles, they are excited by that influence to become attractive to matter, and to each other, at the ſame time:—their attraction to matter is the attraction of arrangement, by which either of the powers becomes atmoſpheric; and their attraction to each other is the attraction of combination.

6. If, then, the two powers, thus excited by the influence of matter, be combined, and become ſuddenly diſengaged, ſtill, *retaining* their excitement, they muſt ſtill be both attractive to each other and to *matter*, as thoſe two tendencies are ſimultaneous and inſeparable; conſequently, the two powers will have a tendency to attract matter, and to *recover* their ſtate of *ar-*

rangement; they, therefore, as ſoon as diſengaged from their former principles, powerfully inſinuate themſelves between particles of matter near them, whatever be their ſtate of exiſtence; they will arrange themſelves around thoſe particles, or will enter into arrangement with the powers already connected with that matter; conſequently, the powers connecting thoſe material principles together, by this acceſſion of the diſengaged powers, in the ſtate of excitement, will be extended in their arrangement; the particles they ſurround will not be ſo cloſely combined as before, hence, the *expanſion*; and, being leſs powerfully attracted together, by being more diſtant, they will become more liable to decompoſition.

7. It is not conſiſtent with my preſent plan to go over the ground that I have before repeatedly trodden; I ſhall not, therefore, extend my obſervations, but only ſay, that fire is formed of the æthereal and phlogiſtic powers, in an excited ſtate, combined together, and becoming diſengaged from the material principles by which

they were excited; as when pure and inflammable airs are exploded together, the æthereal and phlogiſtic powers attract each other, till the acid and antacid principles come in contact, and combine; when the æthereal and phlogiſtic atmoſpheres become diſengaged in their excited ſtates, attracting each other. In this ſtate of excitement, they form *fire*; and have a tendency to *arrange* themſelves around *matter*, as well as to attract each other; and, therefore, will *attach* themſelves to any kind of matter near them. If the calx of mercury be that matter, the excited æthereal power will attract and arrange itſelf around the particles of the acid particles, and convert them into pure air; while the excited phlogiſton will attach itſelf to the earth of the mercury, and reſtore it to its metallic ſtate, if there be fire enough to *ſeparate* the earth and acid.

8. If fire paſs into ice, it will extend the arrangement of the powers attracting the acid and antacid principles forming the ice, till they are too extenſive to retain the material

principles any longer in ſolid combination; and, if the quantity of diſengaged æther and phlogiſton, in the igneous ſtate of excitement, be great, they will ſtill continue to arrange themſelves around the material principles, till thoſe principles become too diſtant to attract each other any longer, ſo as to prevent the full and perfect atmoſpheric arrangement from taking place, when the whole is converted into vapour.

From what has been thus advanced, in a general manner, upon a ſubject of ſuch great importance and extent, I draw the following general concluſions:

1ſt. There are *two material principles* which conſtitute the baſes of all bodies, ſolid, fluid, or aeriform; which I call the *acid* and the *ant-acid*, or *alkaline* principles.

2d. There are *two powers* univerſally diffuſed, which I call the *æthereal* and *phlogiſtic* powers;—they are eſſentially diſtinct from matter, and, by co-operation, they produce *attraction*, which imparts motion to matter.

3d. The acid principle has a peculiar affinity with the æthereal power; by which, that power is excited to arrange itſelf in an atmoſpheric ſtate, around the acid principle.

4th. The antacid principle has a peculiar affinity with the phlogiſtic power; exciting it to atmoſpheric arrangement around it.

5th. The *ſimple* particles of matter impart to the two powers the excitement diſtinguiſhed by the peculiar properties which we call *chemical.*

6th. Particles of the material principles, in different ſtates, with reſpect to the powers connected with them, or their connexion with each other, give to the æthereal and phlogiſtic powers *different* kinds of excitement; the chief of which are the *electric*, *magnetic*, and *common* excitement, or that of univerſal expanſion.

7th. Whenever the powers, in their common ſtate of diffuſion, are ſeparately excited to any particular ſtate, they become *atmoſpheric*; but, an atmoſphere cannot be formed by one power in any ſtate of excitement, without the other power, at the ſame time, aſſuming a ſimilar ſtate and properties.

8th. When either power is excited to any ſtate of arrangement around matter, it *repels*, or reſiſts the approach of another atmoſphere of the ſame power, in a ſimilar ſtate of excitement, as ſoon as thoſe atmoſpheres come into contact.

9th. When an atmoſphere of the æthereal power, in any ſtate of excitement, comes in contact with a phlogiſtic atmoſphere, in a ſimilar ſtate of excitement, they *attract* each other to combination; and by that power of combination, they draw the particles of matter which they reſpectively ſurround, into combination alſo.

10th. When the two powers are excited by the influence of matter, to aſſume the atmoſpheric ſtate, in any degree or kind of excitement, ſo ſoon as thoſe excited powers are ſeparated, each becomes capable of exciting a *ſecondary*, or *external* atmoſphere, of conſiderable extent, around it; which it acquires from the powers in their common ſtate of general diffuſion; each power in its ſtate of excitement, attracting the contrary power to become atmoſpheric around it.

11th. Thoſe external atmoſpheres, like their primary ones, reſiſt the approach of ſimilar atmoſpheres, nearer than the point of contact; and, a ſecondary atmoſphere of the æthereal power, attracts the ſecondary phlogiſtic atmoſphere to combination.

12th. Secondary atmoſpheres are entirely pendent upon their primary atmoſpheres, and can neither permanently combine, nor become diſengaged, till the primary atmoſpheres of the two contrary powers come in contact, and combine; in which caſe, the contrary external atmoſpheres will regain their freedom.

13th. Each power, by the influence of matter, acquires an attraction of *arrangement* around matter; and an attraction of *combination* to the contrary power in a ſimilar ſtate.

14th. Thoſe attractive tendencies *reciprocate* with each other; ſo that, as the attraction of combination, between the primary atmoſpheres, or the contrary material principles, increaſes; their power of exciting external atmoſpheres into arrangement, diminiſhes; and *vice verſa*.

15th. If the two powers in a ſtate of powerful excitement, by the influence of matter, combine, and become *diſengaged* from the matter by which they were excited, ſtill, *retaining* their excitement by being in combination, they form *fire*; and, as one invariable condition of excitement is to render the *powers* diſpoſed to attract matter and *arrange* themſelves around it, as well as to attract each other, thoſe powers in their excited ſtate, conſtituting fire, will powerfully tend to attract matter and *arrange* themſelves around it, ſo as to recover that ſtate which was eſſential to their production, and is alſo eſſential to their excited ſtate.

16th. If the æthereal and phlogiſtic powers excited by matter, by drawing their reſpective material principles into contact, regain their freedom, and in powerfully excited ſtates combine together, they will form fire; and if abundantly copious, will have ſo ſtrong a tendency to arrangement around matter, as to overpower the attraction of combination by which the particles of ſurrounding bodies are held together.

17th. As the powers form atmoſpheres of different extent, and as their degree of excitement is proportionate to the extent in an *inverſe ratio*, thoſe powers may combine together in different ſtates of excitement; and, conſequently, the *fire* which they form by that combination may be in *different* ſtates of excitement alſo, and its powers of action upon matter in various degrees of *intenſity*.

18th. The æthereal and phlogiſtic powers, in their common ſtate of equal and *univerſal diffuſion*, are capable of being excited by thoſe powers in certain ſtates of peculiar excitement from matter; and particularly when they combine together in ſuch ſtates of high excitement as to form fire, particularly active:—the common principles thus excited, tranſmit that excitement in all directions, in rectilinear progreſſion, if not interrupted; which progreſſive excitement conſtitutes *light*.

19th. If the lucific excitement paſſes near to the ſurface of a body, it is drawn out of its rectilinear courſe, towards the body; and its progreſſion afterwards is not parallel with the direction in which that excitement is propagated, by thoſe powers, not ſo near to the ſurface of the intervening body.

This fact powerfully corroborates the preceding obſervations and poſitions; it proves that *all* bodies, being compoſed of the material principles, excite the common powers to *atmoſpheric arrangement* around them, in ſome ſtate or other; though thoſe ſtates are not ſo ſtrikingly evident as the chemical, magnetic, electric, and gravific ſtates of arrangement; and it likewiſe proves that the powers excited by matter *are* capable of exciting *ſecondary* atmoſpheres around them.

20th. When the common powers propagate this lucific excitement, to atmoſpheres, connected with matter, which *attract* theſe powers; by that attraction, the lucific excitement is converted into the attraction of combination; the æthereal and phlogiſtic powers, therefore, combine, by this influence from matter and conſtitute fire; having acquired the tendency to arrangement with matter, at the ſame time that they became attractive to each other, by the influence of the matter which arreſted them in their lucific ſtate of excitement.

Having thus taken a general view of the powers and principles which nature employs in her operations, and the common laws by which they are invariably governed, when co-acting with each other; I ſhall now reſume the ſubject of the 4th ſection.

SECTION VII.

On muſcular contraction.

1. THE reſults of the inveſtigations in the firſt four ſections, were—

That there are two material principles; the acid and antacid principles; of which muſcular fibres are formed.

That there are two powers, having each its affinity to one of the material principles; one the æthereal, the other the phlogiſtic power.

That thoſe two powers, when excited by connexion with the material principles, are capable of atmoſpheric arrangement, and are attractive to each other.

That the brain is formed of two diſtinct portions; the cerebrum and cerebellum.

That every complete or common nerve is formed from, or connected with, both the cerebrum and cerebellum.

That the cerebrum ſeparates one of the powers from the blood; and the cerebellum the other.

That every complete nerve being connected with both the cerebrum and cerebellum, is compoſed of nervous fibres from each; therefore, every common nerve conveys both the æthereal and phlogiſtic powers, by fibres, diſtinctly extended, from each portion of the brain.

That the powers conveyed by the nerves, are eſſentially neceſſary to the production of muſcular contraction.

That the blood, alſo, is eſſential to the due action of a muſcle.

That the blood requires conſtant ſupplies of the acid principl with its æthereal power; and of the antacid principle, with its phlogiſtic power.

That the brain and nerves derive their reſpective powers from the blood; and their functions ceaſe, when the blood is exhauſted of thoſe powers.

That the muſcles themſelves require the preſence of blood, duly ſupplied with its material principles and powers, to enable them to act with effect.

That muſcular fibres are formed of particles of the material principles, ſingly arranged, and ſimply connected together, by fibrillæ of common and ſimple conſtruction.

That the particles in *muſcular arrangement* are, in their common inactive ſtate, conſiderably diſtant from each other.

That every other material particle is connected with a ſimple nervous filament, conveying the *phlogiſtic* power from one portion of the brain; while every intervening or alternating particle, is connected with a ſimple nervous filament, conveying the *æthereal* power from the other portion of the brain.

That the flow of theſe *two diſtinct powers* to their reſpective particles of matter, thus alternately arranged, with the aſſiſtance of the blood, produces muſcular contraction, by *attracting* thoſe alternate particles into contact; and,

That the æthereal and phlogiſtic powers, thus combining, and becoming *diſcharged* from their reſpective nerves, conſtitute *animal heat.*

A difficulty then occurred; as the powers flowing along the nerves could not be in an atmoſpheric ſtate, and as the material particles in muſcular arrangement muſt be conſiderably diſtinct, when not in action, how were we to account for thoſe powers becoming ſo extenſively atmoſpheric around the material particles, as to extend from one to the other; which is neceſſary to enable them to draw thoſe particles into contact?

That difficulty I ſhall now attempt to ſurmount, by explanation.

2, In the 6th ſection, when conſidering the peculiar properties of the material principles, and the æthereal and phlogiſtic powers, in certain ſtates of co-action, I endeavoured to prove, from various obſervations and facts, that it is an invariable law, when the two powers are excited and ſeparated by the influence of the material principles, that each power in its excited ſtate of ſeparation, will form an atmoſphere of ſmall extent around the matter it is immediately connected with; and, in thoſe ſtates, that each power will alſo excite an *external* atmoſphere of greater extent around it, by communicating a *ſecondary* excitement to the common powers, at all times exiſting, in ſome ſtate or other, around them.—This was particularly conſidered and explained as the ſecond general law, and arguments were brought to prove that it invariably takes place whether the powers be excited to the chemical, magnetic, or electric ſtates of arrangement; the kind of excitement depending upon the peculiar ſtate of the material principles exciting them.

3. A nerve, then, ſupplying a muſcle, conveys both the æthereal and phlogiſtic powers, from the cerebrum and cerebellum; when it arrives at the muſcle, its æthereal power paſſes by a diſtinct filament to one material particle in muſcular arrangement, and its phlogiſtic power by another nervous fibrilla, to another particle, the next we will ſuppoſe in ſucceſſion, but conſiderably diſtant; a number of theſe parti-

cles, in alternate arrangement, forming a muſcular fibre.

4. Theſe two powers are ſeparate, and *excited* by the vital or animating powers, when they flow along their diſtinct fibrillæ; becauſe, when not excited, they do not flow to the particles in muſcular arrangement.

5. Theſe powers diſtinctly excited, and diſtinctly flowing to their reſpective particles in muſcular arrangement, will, ſo ſoon as they are communicated to thoſe particles, *diffuſe* themſelves around them in the ſtate of ſmall atmoſpheres highly excited; and each will, therefore, by the common law which always takes effect in ſimilar circumſtances, excite to ſecondary arrangement, a more extenſive atmoſphere of the contrary power; which external atmoſpheres the two nervous powers meet with in the blood, ſo neceſſary to their due effect.—Thoſe *ſecondary* atmoſpheres will, therefore, *attract* each other; they will draw their reſpective primary atmoſpheres into *contact*; and

with them the particles of *matter* in *muſcular arrangement*, which they reſpectively ſurround :—by that combination, the contrary powers will deſtroy each other's excitement and arrangement, and will combine and form fire; which diffuſing itſelf into the blood preſent, conſtitutes that degree of *heat* peculiar to *animal life*.

6. The excitement which is given to the æthereal and phlogiſtic *powers* by the *vital* or *animating* principle, then, greatly reſembles the electric excitement of the ſame powers.—In both ſtates the primary excited powers form atmoſpheres of ſmall extent; in both ſtates, thoſe atmoſpheres, when ſeparated from each other's influence, acquire extenſive atmoſpheres of the contrary powers around them, by ſecondary excitement;—in both ſtates, thoſe ſecondary atmoſpheres around the two different powers, attract each other, and, by that attraction, draw the primary atmoſpheres, and the material particles they ſurround, into contact; and in both ſtates, when the two primary

atmoſpheres combine, they quit their atmoſpheric ſtates and properties, and leave their reſpective material particles *deprived* of their *attractive* influence; to which particles they never had more than a ſlight, ſuperficial attachment, as being communicated to them, and not excited by them.

7. Greatly as the vital and electric ſtates of excitement, communicated to the æthereal and phlogiſtic powers, reſemble each other, ſtill, however, they have their differences; and one peculiarity particularly marks the diſtinction between them; which is, that whenever the æthereal and phlogiſtic powers are excited to the electric ſtate, and ſeparated, each, inſtantly, excites its ſecondary atmoſphere which conſtantly attends it, and, together, they uniformly expand over *all* conducting ſurfaces near them, unleſs peculiarly attracted to one part by the contrary powers:—but, when the two powers are excited by the *animating* principle, the caſe is widely different, as is peculiarly evident in volition; for, when the intellectual

powers tranſmit excitement, by a nerve, to any particular muſcle, that excitement is communicated to both the æthereal and phlogiſtic powers, and proceeds directly from the brain to the *muſcle* whoſe action is determined upon; conſequently, when excitement is communicated by the intellectual powers, that excitement is *confined* to the *very fibres* of the *nerves* which ſupply the *muſcle* to be moved; and the two powers which diſtinctly receive that excitement, neither communicate it to contiguous nervous fibres, nor aſſume the atmoſpheric ſtate of excitement, till they *flow* from the extremities of their reſpective nervous fibrillæ, to the *material* particles in muſcular arrangement, in which they terminate; then, and not till then, they become ſubject to the common law; each aſſumes its primary ſtate of arrangement, and each excites its ſecondary atmoſphere, and reſembles, in all its properties, the ſimilar powers in the electric ſtates of excitement.

8. Intellectual excitement, then, ſeems to be

propagated by the power of *animation* reſident in every nerve; and that animating power only excites the æthereal and phlogiſtic powers ſubject to its influence, to become atmoſpheric, when it communicates them to their reſpective material particles, in which the animated nervous fibrillæ terminate; each power paſſing by its reſpective nervous fibrillæ to its reſpective material particles in muſcular arrangement.

9. If, then, the vital or animating excitement be communicated to the two powers of the common nerve, thoſe powers being mutually excited and ſeparated, will flow from their reſpective nervous fibrillæ, to the material particles in muſcular arrangement, in which they diſtinctly terminate, and around which they will arrange themſelves, ſo as to form powerfully excited atmoſpheres, but of *ſmall* extent.

It is poſſible that theſe *powers, alone*, may produce muſcular contraction, by flowing in ſuch quantities as to come within each other's influence, when ſurrounding their reſpective material particles; but I by no means think it probable; becauſe, if they were communicated by the nerves in ſuch proportions as to attract each other, and their reſpective material particles into contact, why is the preſence of the *blood*, properly ſupplied with pure air and phlogiſtic aliment, ſo eſſentially neceſſary to muſcular action?—And, again, why ſhould nature diſpenſe with a general law, in this caſe, which ſhe invariably obſerves in producing ſimilar effects, by the ſame powers, in other ſtates of excitement?—For inſtance, when two diſtant particles of matter acquire, the one a phlogiſtic, the other an æthereal atmoſphere in an electric ſtate, thoſe atmoſpheres, invariably, attract around them ſecondary atmoſpheres of wide extent; thoſe external atmoſpheres are evidently different from their primary exciting atmoſpheres; they may attract each other, and be ſeparated again, unaltered, and unaffected by each other; but, the two contrary, primary atmoſpheres inſtantly deſtroy each other's arrangement, and electric properties, by coming into contact. I, therefore, conclude, that the two powers, excited to flow from the nerves, to the material particles in muſcular arrangement, form ſmall excited atmoſpheres, which *do not* extend to each other.

10. The æthereal and phlogiſtic powers, then, thus excited around their reſpective material particles, and not being within each other's influence, will, according to the 2d general law, immediately excite the *two powers* exiſting in the *blood,* there preſent; the æthereal power excited around the 1ſt, 3d, 5th, &c. material particles, will excite ſecondary atmoſpheres of phlogiſton, while the phlogiſtic power excited around the 2d, 4th, 6th, &c. particles, will excite the æthereal power of the blood, to form ſecondary atmoſpheres around them.

11. Theſe ſecondary or external atmoſpheres being formed of the contrary powers in ſimilar ſtates of excitement, will, then, attract each other, as extending within each other's influ-

ence; by that attraction, they will draw their reſpective primary exciting powers into contact, and with them the material particles they reſpectively ſurround, till thoſe primary atmoſpheres, by coming in contact, combine, and quitting their connexion with the material particles, loſe their nervous excitement, and conſtitute fire; in which ſtate they will paſs into the blood of the muſcle: by the combination of the primary atmoſpheres, the external atmoſpheres will alſo become diſengaged, and combining in an excited ſtate, will *not* return to their former combinations in the blood; conſequently, the acid and antacid principles they were chemically combined with, will be left combined together, in a ſaline ſtate, in the blood; and the neceſſity for freſh ſupplies of air and food to replace thoſe principles, thus diſcompoſed, muſt be proportionate to the degree of muſcular action.

When the *material particles* are drawn ſo near to each other as to enable the primary atmoſpheres to come in contact, they muſt be *greatly* approximated; the connecting, ſimple filaments, neceſſarily muſt become *curved*, or *bended aſide*; the muſcular fibre muſt become greatly *contracted* in its length, and the ſolid parts to which its extremities are connected, muſt, therefore, be brought *nearer* to each other, if the fibre were ſo connected; or, the length and circumference of the veſſel muſt be *diminiſhed*, in whoſe compoſition the fibre forms a part.

From what has been advanced, then, I draw the following general concluſions:

1ſt. That the cerebrum and cerebellum ſeparate the æthereal and phlogiſtic powers from the blood.

2d. That the cerebrum ſeparates one power, the cerebellum the other.

3d. That the medulla oblongata, the medulla ſpinalis, and every nerve proceeding from them, are formed by the cerebrum and cerebellum.

4th. That every nerve, therefore, conſiſts of diſtinct fibres from both the cerebrum and cerebellum.

5th. That every nerve contains both the æthereal and phlogiſtic powers; each power being connected with its diſtinct fibres: the fibres connected with the cerebrum conveying one power; thoſe connected with the cerebellum the other.

6th. That theſe powers in the nerves are put in motion by the influence of the vital or animating powers, inherent in the brain and nerves.

7th. That the powers in the nerves thus put in motion, diſtinctly flow by their reſpective fibrillæ, to the material particles in muſcular arrangement, diſtant from each other, but connected by ſimple filaments.

8th. That the particles receiving the æthereal power of the nervous fibrillæ, alternate with thoſe connected with the phlogiſtic nervous fibrillæ.

9th. That theſe powers thus excited form atmoſpheres of ſmall extent around their reſpective material particles.

10th. That the excited atmoſpheres, thus communicated from the nerves to the material particles of the muſcular fibres, excite ſecondary and extenſive atmoſpheres around them, which they acquire from the æthereal and phlogiſtic powers in the blood there preſent.

11th. That the external atmoſphere, thus formed around each material particle, is ſufficiently extenſive to be within the influence or extent of the next adjoining atmoſphere.

12th. That two external or ſecondary atmoſpheres thus in contact, will attract each other;

becauſe the contrary powers forming thoſe atmoſpheres alternate with each other.

13th. That by that attraction the primary atmoſpheres, which were immediately communicated from the nerves to their reſpective material particles, will be brought together, and with them the material particles themſelves.

14th. That by this approximation of the material particles, the muſcular fibre which they form will be ſhortened.

15th. That the æthereal and phlogiſtic powers communicated to thoſe particles by their reſpective nervous fibrillæ, being thus brought into contact, will combine, and form fire; which, paſſing into the blood, conſtitutes animal heat.

16th. That the æthereal and phlogiſtic powers of the blood which were excited to form the ſecondary atmoſpheres, will combine alſo, and the acid and alkaline principles from which they were ſeparated, will form a neutral ſaline compound; which will remain commixed with the blood till ſeparated by the glands, and expelled.

17th. And that the blood muſt require ſupplies of the æthereal acid and of the phlogiſticated antacid principles, in proportion to the expenditure of thoſe powers and principles by muſcular action.

Thus, then, I explain muſcular contraction of every kind; that is, the contraction of every muſcular fibre I ſuppoſe to be effected by the [*two powers* conveyed by the nerves, *attracting* the component *particles* of *muſcular fibres* nearer to each other, in the manner, or upon the principles, or according to the general laws which I have explained (ſect. 6th.) But, muſcular fibres are very different from each other in one reſpect; which is, the mode of their being excited to action. Some muſcular actions being excitable by the will; while others act independently of it, and can neither be reſtrained, nor accelerated in their actions, directly, by any determination or effort of the mind.

Still, however, in all caſes, the ſimple muſcular fibre, or the ſimple material particles in muſcular arrangement are *paſſive*; conſequently, the reaſons why certain muſcles are ſubſervient to the will, and others are not, muſt be ſought for in the different ſtates or conditions of the *nerves*, by whoſe powers the muſcular fibres are contracted.

As the muſcles ſubſervient to the will, and the nerves connecting them with the brain, ſeem to be the ſimpleſt in their conſtructure, I ſhall, firſt of all, direct my attention to them, under the general title of *voluntary muſcles*, or muſcles of volition; and, then, I ſhall conſider the other claſs, or the *involuntary muſcles*; by which I ſimply mean all the muſcles, or muſcular fibres, whoſe actions are not under the direct influence of the will. Voluntary and involuntary I apply to the two claſſes, as terms of conveniency, without contending for their ſtrict propriety.

SECTION VIII.

On the voluntary muſcles, and the nerves by which they are connected with the brain.

1. THE voluntary muſcles are chiefly thoſe of the trunk of the body, of the legs and arms, and of the face.

2. Each voluntary muſcle requires the preſence of the blood with its proper principles, and the powers of the nerves, to excite it, or rather to cauſe it to contract; conſequently, every voluntary muſcle requires a *free* intercourſe with both the brain and the heart, to enable it to diſcharge its functions; for, if the nerve which connects it with the brain be cut, it inſtantly ceaſes to contract, in obedience to the will; and if the arteries which ſupply it

with blood, be cut, its power of contracting is inſtantly weakened.

3. If the nerve be cut, and that portion below the ſection be irritated, irregular contractions of the muſcle will be excited; becauſe the nerve ſtill retains its uſual proportion of the æthereal and phlogiſtic powers, and alſo the property of ſecreting thoſe powers from the blood:—and if the arteries be cut, which ſupply it with blood, it ſtill will be capable of contracting in ſome degree, when it receives the nervous powers, becauſe it ſtill retains a portion of blood, in the numerous veſſels diſtributed to it; and ſimply cutting its proper artery, in general, is not ſufficient to deprive it of blood, on account of the anaſtomoſes of the different blood veſſels of neighbouring parts with each other.

4. When volition is excited in the brain, that excitement is tranſmitted along the nerve to the muſcle, whoſe action is determined upon: that voluntary excitement communicated from the

brain to the common nerve, does not, however, excite the æthereal and phlogiſtic powers to become atmoſpheric *in the nerve*; becauſe, in that caſe, thoſe powers could not paſs along the ſimple nervous fibres to which they properly belong, without attracting each other, as being in contact; nor without exciting the powers in the numerous nervous fibres in the ſame bundle, which branch off from the common trunk of the nerve to different muſcles.

5. The excitement of volition, then, when tranſmitted to the voluntary nerve, is ſimply the excitement of *progreſſion*; that is, the æthereal and phlogiſtic powers, appertaining to the correſpondent nervous fibrillæ, proceeding together to any particular muſcle, are, ſimply, excited to move towards the extremities of their reſpective fibrillæ; when there, they will flow to the material particles in muſcular arrangement, in which thoſe nervous fibrillæ reſpectively terminate:—the two powers thus excited to flow, will ſurround their reſpective material particles in an excited ſtate; each power will excite its

contrary power which it meets with in the arterial blood, to form an external atmoſphere around it; and thoſe external atmoſpheres will *attract* each other, and alſo their reſpective powers which were excited by, and communicated from, the nerves; and with them, the material particles in muſcular arrangement; by which, the contraction of the muſcular fibres will be effected, as already explained, ſect. vii.

6. It is evident, then, that the nerves of volition ariſe from the brain, and are immediately expoſed to the influence of the intellectual powers: that thoſe powers determining upon the contraction of a muſcle, tranſmit an excitement to the correſpondent nervous fibrillæ, which convey the æthereal and phlogiſtic powers to *that* muſcle: that that excitement is ſimply the excitement of progreſſion, by which the two powers are made to flow towards their reſpective extremities: that the æthereal and phlogiſtic powers thus ſimply flowing along their reſpective fibres, are communicated to their reſpective material particles in muſcular arrangement: that they

then excite ſecondary atmoſpheres which they acquire from the powers in the blood in the muſcle, by which the material particles are attracted towards each other, and the muſcle is ſhortened; and that the nerve forms a free and uninterrupted intercourſe between the brain and the muſcle.

SECTION IX.

On involuntary muſcles, or the actions of the heart and vaſcular ſyſtem; with the peculiar ſtructure of their nerves, and the manner in which they are excited.

1. THE involuntary muſcles are chiefly the heart, and vaſcular extremities. By vaſcular extremities I mean the extremities of the arteries and veins in every part of the body, whether it be the brain, the lungs, the muſcles themſelves voluntary or involuntary, the liver, ſtomach, inteſtines, or, in ſhort, any part into whoſe compoſition the arteries and veins enter; for that theſe remote ramifications have a peculiar muſcular action of their own, by which they propel the blood they contain, is too evident, too neceſſary to admit of a doubt; conſequently, theſe vaſcular extremities muſt be interwoven

with muſcular fibres, which form a conſiderable part of that claſs which I call involuntary muſcular fibres, as acting independently of the will.

2. The action of an involuntary muſcle, is, in effect, exactly the ſame as that of a voluntary muſcle: it is merely a contraction; that contraction is ſimply an approximation of its conſtituent particles; that approximation is the effect of attraction drawing thoſe particles towards each other; that, like every other attraction, is the effect of the æthereal and phlogiſtic powers in excitement, combining with each other; and thoſe æthereal and phlogiſtic powers muſt be conveyed to the muſcle by the nerves, as when they produce voluntary action by being communicated to the voluntary muſcles; and the neceſſity of the blood, being preſent to aſſiſt in the operation, is too evident to need inſiſting on.

3. That the *nerves* communicate the *powers* which cauſe the involuntary muſcles to contract, is evident from analogy with the voluntary muſcles; it is inconteſtably proved, alſo, by

this conſideration, that if the communication between the brain and the involuntary muſcles be deſtroyed, by cutting the connecting nerves, their actions ceaſe; not indeed immediately, becauſe the nerves, during life, at all times, contain a conſiderable portion of the æthereal and phlogiſtic powers, and have, likewiſe, moſt probably, the power of ſecreting it from the blood; conſequently, if the communication with the brain be deſtroyed, ſtill the nerves of the involuntary muſcles will be capable of being excited, ſo long as the powers they contain are unexhauſted.

4. That the preſence of the *blood* duly ſupplied with its æthereal and phlogiſtic powers, is alſo eſſentially neceſſary to the action of involuntary muſcles, cannot be denied; becauſe their actions are immediately weakened by the loſs of blood in a conſiderable quantity; by the blood being deſtitute of pure *æthereal* air; or, by its being exhauſted of the *phlogiſticated* principle derived from proper aliment; conſequently, not only the blood, but alſo the æthereal and phlo-

giſtic powers, with their reſpective material principles, are neceſſary to the action of the involuntary muſcles. The heart, indeed, may contract, when its auricles and ventricles are emptied of blood, becauſe, though thoſe cavities contain no blood, ſtill, the arteries and nerves every where interwoven with the muſcular fibres, forming the very *ſubſtance* of the heart itſelf, ſtill retain their blood; and till that blood, and the nerves accompanying it, to every muſcular fibre of the heart, be exhauſted of their powers, the heart may be excited to contract; unleſs the vital principle itſelf, which excites thoſe powers to motion, be deſtroyed.

5. I aſſume it then as a fact, that the involuntary muſcular fibres are made to contract, by the æthereal and phlogiſtic powers communicated by the nerves, exciting the powers in the blood; by the attraction of which contrary powers, the component particles of the involuntary muſcular fibres are drawn together, and the fibres ſhortened; in the ſame manner as the contraction of the voluntary muſcular fibres is ef-

fected; and, therefore, I ſhall not again repeat the particulars of the proceſs.

6. It is now proper to conſider, why theſe involuntary muſcles are *not* ſubject to the will, as the voluntary muſcles are, ſince their actions are both produced, in the ſame manner, by the conjoint influence of the powers of the nerves and in the blood. That reaſon muſt be ſought for in the conditions of the *nerves* themſelves; and a ſlight attention to the reſpective nerves, ſupplying the two claſſes of muſcles, will be ſufficient to point out that reaſon.

7. It has already been obſerved (ſect. viii. 2.) that the intercourſe between the brain and the voluntary muſcle muſt be uninterrupted; and if we examine thoſe nerves of volition, we find that they are free, and uninterrupted in their courſe; but, as the influence of the brain cannot be directly tranſmitted to the *involuntary* muſcles, it muſt follow, that the connecting nerves muſt be *interrupted* in their courſe between the brain and thoſe muſcles; and anatomy teaches us that

every nerve, paſſing from the brain to thoſe involuntary muſcles, *does* paſs into one or more *ganglia*; and from thoſe ganglia they proceed to the involuntary muſcles; but, not unfrequently, that progreſs is again interrupted by moſt intricate plexuſes. The ganglia are invariably found to intercept the nerves of the involuntary muſcles: they are never found in any part of the courſe of the nerves of volition; therefore, it is a reaſonable deduction, that the ganglia do interrupt the direct intercourſe between the brain and the muſcular fibres, whoſe actions are involuntary.

8. The *intercoſtal* or *great ſympathetic nerves* are the grand ſource, from whence the nerves ſupplying the heart, and the vaſcular extremities of the ſtomach, inteſtines, liver, and abdominal viſcera in general, are chiefly ſupplied; the actions of all thoſe parts are involuntary, and the nerves by which they are ſupplied, are ſent off from the ganglia of the intercoſtals. In fact, the intercoſtal nerves ariſe, commonly, from the fifth and ſixth pair of the medulla oblongata,

and from *all* the *ſpinal nerves,* in ſucceſſion, which ſend off branches which paſs into the ganglia of the intercoſtals, and from thence to the muſcular fibres of the heart, and vaſcular extremities of the parts mentioned.

9. The æthereal and phlogiſtic powers of the brain, then, flow along their reſpective nerves to the ganglia of the intercoſtal nerves; and from thoſe ganglia they flow along the nerves, proceeding from them to the heart and vaſcular extremities.

The ganglia, then, do not intercept the flow of the two powers from the brain to the voluntary muſcles; but they receive them from the brain by the nerves intervening, and then tranſmit them by nerves proceeding from them to the involuntary muſcles; they, therefore, prevent the brain from tranſmitting the two powers, *directly,* by an uninterrupted courſe to any involuntary muſcle; and they prevent impreſſions made upon the extremities of thoſe nerves, from being, *immediately*, conveyed to, or perceived by the brain.

10. The intercoſtal nerves, then, are, as it were, two chains of ganglia, from which the muſcles are ſupplied, which perform the conſtant and involuntary actions requiſite for the circulation of the blood through the heart, and the blood veſſels in the ſtomach, inteſtines, liver, and, in ſhort, all the abdominal viſcera in particular. But, there are other involuntary actions of the vaſcular extremities, ſtill more diſtant from the heart, or centre of the circulating powers by which the blood is moved; theſe are the arterial and venous extremities forming ſo large a portion of all the *voluntary* muſcles *themſelves,* of all the extremities: the more diſtant thoſe vaſcular extremities are from the heart, the more neceſſary is the action of the muſcular fibres, interwoven *with* thoſe vaſcular extremities.

11. The vaſcular extremities, therefore, of the voluntary muſcles, muſt have an *involuntary*

action, by which the blood is propelled through them, at all times, whether the muſcle be in voluntary action or not; and as the circulation of the blood through thoſe diſtant muſcles muſt be chiefly effected by the involuntary actions of the ſanguiferous veſſels themſelves, it is evident, that a conſiderable portion of nervous powers, muſt be conſtantly neceſſary, to keep up thoſe actions; and, as thoſe muſcular fibres which perform thoſe actions are involuntary, the nerves, by which thoſe muſcular fibres are ſupplied with power, muſt be intercepted by *ganglia*, in their courſe from the brain to thoſe vaſcular extremities.

12. If we attend to the anatomy of thoſe parts, and of the nervous ſyſtem, we inſtantly perceive that the voluntary muſcles are ſupplied with nerves paſſing through ganglia.

All the ſpinal nerves, which are the nerves diſtributed to the voluntary muſcles, are formed of bundles of nervous fibrillæ, ariſing from both the anterior and poſterior parts of the medulla ſpinalis. The anterior bundles combine with the poſterior, and paſs free from interruption, from the medulla ſpinalis to the voluntary muſcles; conſequently, thoſe nerves form a free intercourſe between the brain and the voluntary muſcles: but, the *poſterior* faſciculi of nerves, ariſing from the medulla ſpinalis, *paſs* into *ganglia*, before they unite with the anterior faſciculi and proceed in one common bundle to the muſcles of volition.

13. The ſpinal nerves, diſtributed to the voluntary muſcles, then, are formed of bundles of nervous threads ariſing from the anterior part of the medulla ſpinalis, which paſs freely and without interruption to the voluntary muſcles; and of bundles of nervous fibrillæ, ariſing from the *poſterior* part of the medulla ſpinalis, which *paſs* into *ganglia*; and from thoſe ganglia nervous fibres proceed, and coaleſce with the anterior nerves, to form the common nervous trunks which are diſtributed to the voluntary muſcles. The anterior branches of the ſpinal nerves being free from interruption, convey the

powers, excited by volition, to the muſcles, which are obedient to the will; and the poſterior branches having paſſed through ganglia, are diſtributed to the muſcular fibres of the blood veſſels in the voluntary muſcles to keep up their involuntary actions, without being under the influence of the will.

14. It appears very evident, then, that every nerve which paſſes in an *uninterrupted* courſe from the brain, or the medulla oblongata, or ſpinalis, which are formed by the cerebrum and cerebellum, to a muſcle, is a nerve of volition; and that every nerve proceeding from the brain, and paſſing into a *ganglion*, before it is diſtributed to a muſcle, is *not* under the power of the will, when it paſſes from the ganglion to the muſcle to which it is diſtributed.

15. A nerve of volition, then, conveys the powers excited to flow along it by mental volition, in a *direct* courſe to the material particles in muſcular arrangement; thoſe powers flowing along their reſpective nervous fibrillæ, to their

correſpondent muſcular particles, ſurround them in a ſtate of excitement; each power excites its ſecondary atmoſphere, which is formed of the powers in the blood, and thoſe atmoſpheres of the contrary powers, by attracting each other, produce the contraction of the muſcular fibre, as before (ſect. vii.) amply explained.

16. But, as the nerves which paſs to the heart, and the extremities of the blood veſſels, in every part of the ſyſtem, are interrupted by paſſing through ganglia, the powers excited to flow from the brain to thoſe nerves, cannot *directly proceed* further than theſe ganglia; from whence they flow by a regular *diffuſion* along the nerves ariſing from thoſe ganglia, to be diſtributed to the heart and vaſcular extremities. The flow of the excited powers to the ganglia, is an excitement ſufficient to cauſe them to diffuſe themſelves along the nerves extending to the involuntary muſcular fibres: by that flow the powers are accumulated in thoſe nerves; but, the brain *cannot*, on account of the interrupting ganglia, propagate that excitement, which is neceſſary to

diſcharge the two powers, from the extremities of their reſpective fibrillæ to the muſcular fibres, ſo as to cauſe them to contract.

17. The involuntary nerves, then, ariſing from ganglia, *conſtantly* receive a flow of the æthereal and phlogiſtic powers from the cerebrum and cerebellum, by means of the ganglia; but that is merely the flow of ſimple diffuſion, not of excitement; for though the æthereal and phlogiſtic powers diffuſe themſelves along their reſpective nervous fibres, ſtill, the energy of the vital or animating principle is wanting, to give them that excitement upon which their power of flowing in an excited atmoſpheric ſtate to the muſcular fibres, and cauſing them to contract, depends; conſequently, the involuntary nerves require the application of *ſtimuli* to excite them to propel their powers to the muſcular fibres, ſo as to cauſe them to contract; at leaſt, the application of ſtimuli is neceſſary to excite thoſe nerves to perform their functions with that degree of vigour which is required.

18. That this is in reality the caſe, is abundantly evident; for if the blood be denied the influence of atmoſpheric air in the lungs, the heart will *ceaſe* to act:—when the heart has ceaſed its motions, the application of ſtimuli will excite it to *renew* them, if applied within a certain time; and in caſes of ſuſpended animation the application of pure air to the lungs, will frequently reſtore the involuntary actions of the *muſcles* by its ſtimulating effects upon the *nerves*.

19. It is by no means improbable, that the powers flowing from the brain to the ganglia, may ſtill retain excitement ſufficient to produce their flow from the nervous extremities to the involuntary muſcles, ſo as to keep up a conſtant action, *independent* of any ſtimulus; but, at the ſame time, it muſt be granted, that the application of ſtimuli to thoſe nerves, *does* excite their action; and, that the conſtant application of the natural ſtimuli of pure air and proper food, is neceſſary to excite thoſe involuntary actions to a *due* degree of vigour.

20. It has already been obſerved, (ſect. vii.) that every muſcular fibre, voluntary or involuntary, is made to contract by the æthereal and phlogiſtic powers, flowing in a ſtate of excitement, to their reſpective particles of matter in muſcular arrangement :—we know that certain ſtimuli will excite the heart to contract, even when ſeparated from the body, immediately after its ſpontaneous contractions have ceaſed: we know that the blood, duly ſupplied with its requiſite principles and powers, *does* excite the heart to contract in the living body: we know that the blood does *not* excite the voluntary muſcles to action; and we know that if a nerve of volition be irritated, the voluntary muſcle is put into action; conſequently, the nerves of the voluntary muſcles, are *not* expoſed to the action of ſtimuli, of any kind, in the natural, healthy ſtate, but convey the excitement of volition, directly, from the brain to the muſcular fibres, without being expoſed to the influence of any other exciting cauſe: but, on the contrary, the involuntary nerves *are* expoſed to the influence of the blood, which acts as a *ſtimulus*; and

that ſtimulus excites the nerves to propel their æthereal and phlogiſtic powers, in an excited ſtate, to the muſcular fibres, which cauſes them to contract.

21. If a nerve of volition be irritated in its courſe, the muſcle is thrown into action; therefore the nerves terminate, *directly*, in the muſcular fibres: but if an involuntary nerve be irritated in its courſe, the involuntary muſcle does not contract; which proves that the nerve does *not*, directly, terminate in muſcular fibres; but, that its fibres are *again interrupted* when they reach the muſcle, and then are diſtributed to the muſcular fibres.

22. Whatever be the ſtate which the nerves aſſume, when they reach the involuntary muſcles, it is evident that the excitement of the trunk of the nerves ſtops there, when irritated; and it is evident, that the nerves, thus diſtributed upon the ſurfaces of the blood veſſels and heart, are excitable by ſtimuli; and that from thence the excitement is propagated to the extremities of

the nervous fibrillæ, which immediately terminate in the material particles in muſcular arrangement; ſo that whenever this *nervous expanſion* on the ſurfaces of the heart and blood veſſels is excited, by proper *ſtimuli*, that excitement is propagated by the nervous fibrillæ which proceed from this nervous expanſion to the muſcular fibres themſelves.

23. I think it then ſtrictly allowable to draw the following concluſions:

1ſt. That the nerves of volition proceed from the brain, and paſs in an uninterrupted courſe to the material particles in muſcular arrangement, without being expoſed to any intervening influence.

2d. That thoſe nerves are connected with both the cerebrum and cerebellum, and convey the æthereal power from the one, and the phlogiſtic power from the other, by diſtinct, but correſpondent fibres, to their reſpective material particles, alternating with each other, in muſcular arrangement.

3d. That the involuntary nerves paſs through ganglia, before they are diſtributed to the muſcles of involuntary action; which ganglia prevent the direct intercourſe between the brain and the muſcles, and render them incapable of immediately influencing each other.

4th. That involuntary nerves, like the voluntary, are connected at their origins, *previous* to their entering the ganglia, with both the cerebrum and cerebellum, and convey the æthereal and phlogiſtic powers by diſtinct, but correſpondent fibres.

5th. That the involuntary nerves, proceeding *from* the ganglia, are expanded upon the *ſurfaces* of the heart, and vaſcular extremities, particularly their *internal* ſurfaces, and are intimately *interwoven* with each other; in which ſtate, the nerves with their æthereal and phlogiſtic powers are expoſed to the influence of the blood, or ſuch ſtimuli as are conveyed by the veſſels, within which they are thus expanded.

6th. That from that nervous expanſion, fibrillæ ariſe, which are diſtributed to the material particles in muſcular arrangement.

7th. That when the æthereal and phlogiſtic powers of the nerves, thus mutually expanded on the ſurfaces of the heart and blood veſſels, are excited, by the action of the blood, or other ſtimuli, that excitement cauſes them to flow by their reſpective fibrillæ, to the material particles in muſcular arrangement, in which they terminate.

8th. That thoſe particles being alternately arranged, the powers thus excited to flow around them, will excite the contrary powers in the blood; by the attraction of which the muſcular fibres will be made to contract, as hath already been particularly explained.

SECTION IX.

On the additional influx of power to the heart and vaſcular extremities, or to the involuntary nerves, in conſequence of the exertion of the voluntary muſcles.

1. WHENEVER the voluntary muſcles are excited to action, the contractions of the heart and involuntary muſcular fibres are, proportionately, increaſed in ſtrength and frequency.

2. This increaſed action of the involuntary muſcles, is *not* the effect of *motion*; becauſe, if the voluntary muſcles be violently excited to *rigid inflexibility*, ſtill, the actions of the heart, &c. will be inſtantly *increaſed*; conſequently, the nerves which impart the attracting powers to the involuntary muſcles, muſt receive an additional

flow of thoſe powers from the brain, at the ſame time, that the powers are excited to flow from the brain to the voluntary muſcles.

3. It muſt then follow, that the voluntary nerves have a direct *communication* with the involuntary nerves; ſo that the æthereal and phlogiſtic powers cannot flow along the former without a partial communication to the latter.

4. If we attend to the actual ſtate of the nerves in the human body, we ſhall ſoon be convinced that ſuch is the caſe; for the voluntary muſcles are chiefly ſupplied with their nerves from the medulla ſpinalis; and all the ſpinal nerves ſend off branches which paſs to the ganglia of the intercoſtal nerves.

5. The branches of the ſpinal nerves, then, which are ſent to the ganglia of the intercoſtals, have a direct communication with the voluntary nerves; ſo that no powers can be tranſmitted to the voluntary muſcles, without a portion of thoſe powers paſſing to the intercoſtal nerves, and

from the ganglia of thoſe nerves to the heart, and vaſcular extremities; conſequently, thoſe nerves when expanded upon the ſurfaces of the heart and ſanguiferous veſſels, by this acceſſion of powers, are more capable of acting with vigour, and are more readily and frequently excited by the common ſtimulus of the blood; becauſe this accumulation of the two powers, more quickly reſtores the loſs of thoſe powers when diſcharged to the muſcular fibres, than when the nerves are leſs copiouſly ſupplied with them.

6. For the ſame reaſons we may conclude, that the poſterior fibres ariſing from the ſpinal marrow, and paſſing through ganglia, before they coaleſce with the uninterrupted anterior faſciculi of nerves, to be diſtributed, together, to the voluntary muſcles, are, alſo, ſo connected with the anterior, voluntary portions of thoſe nerves, as to receive a flow of power, in augmentation, whenever the voluntary portions of thoſe nerves are excited; ſo that the vaſcular actions of thoſe muſcles may be increaſed, for

the purpoſe of accelerating the flow of blood through them when in action: for, as the preſence of blood is neceſſary to enable the voluntary muſcles to act, the more thoſe muſcles are exerted, the more blood is neceſſary to ſupport thoſe exertions; and the voluntary nerves thus communicating a part of the powers excited to flow along them to the involuntary nerves, correſponding to them, is wiſely adapted to anſwer that neceſſary end.

7. *All* the nerves of volition, then, *do communicate* by collateral branches with the *intercoſtal nerves*, which ſupply the heart and vaſcular extremities of the abdominal viſcera; and every particular nerve, ſupplying any *voluntary* muſcle, communicates with the involuntary nerve accompanying it to be diſtributed to the extremities of the *blood veſſels* of that muſcle; conſequently, whatever quantity of the æthereal and phlogiſtic powers, is tranſmitted from the brain to the voluntary muſcles, a proportionate flow of thoſe powers muſt paſs to the ganglia of the intercoſtal nerves, and from thence to the heart

and vaſcular extremities of the abdominal viſcera; and, at the ſame time, whatever voluntary muſcle is excited, a proportionate flow of the two powers muſt paſs, in addition, to the involuntary nerves accompanying the voluntary nerve excited, that the involuntary actions of the blood veſſels in the muſcle excited to act, may correſpond to the voluntary exertion of that muſcle, that the muſcular fibres may be ſupplied with blood, in proportion to the want of it to enable the muſcular fibres to contract.

8. Every voluntary nerve, then, muſt have its correſpondent involuntary nerve, that the flow of powers from the brain may be, at all times, proportionate, to both; ſo that the involuntary actions by which the blood is circulated may be proportionate to the voluntary actions requiring that blood to aſſiſt in their contractions:—therefore, every voluntary nerve muſt intimately communicate with its correſpondent involuntary nerve, either in the brain, or in ſome part of its courſe. The voluntary nerves convey their powers *directly* from the brain to the voluntary

muſcle; but the correſpondent involuntary nerves convey their powers to the interrupting *ganglia*, from which the powers *diffuſe* themſelves to all the nerves ariſing from thoſe ganglia: ſo that the powers flowing to the ganglia of the intercoſtal nerves, from whatever voluntary nerve they are derived, diffuſe themſelves to all the parts to which thoſe involuntary nerves extend, below the ganglia; but any of the involuntary ſpinal nerves accompanying the voluntary nerves in their courſe to the voluntary muſcles, of neceſſity, convey their additional excitement to the vaſcular extremities of *that muſcle only*, whoſe correſpondent voluntary nerve is excited.

9. It hath already been obſerved (ſect. vii.) that the nervous fibres, when excited by volition, do not tranſmit their reſpective powers in an atmoſpheric ſtate; but that the *intellectual excitement* is ſimply a *progreſſive motion* of the *powers* along the nervous fibres; which powers only become *atmoſpheric*, when they paſs from the *nervous extremities* to the *material particles* in muſcular arrangement; becauſe, any particular

muſcle may be thrown into action by the will, without other muſcles being affected, although they are ſupplied from the ſame, common, nervous trunk as the former.

10. It is evident, then, that every voluntary muſcle has an immediate connexion with the brain by *diſtinct* nervous fibres, peculiarly appropriated to *that* muſcle alone; and, that nervous fibres, diſtributed to different muſcles, or diſtant muſcular fibres, when excited by the flow of powers from the brain, *do not* communicate their excitement, neceſſarily, to the nervous fibres in the ſame bundle, by contiguity.

11. It is evident, however, that nerves, in ſome caſes, *do* communicate with each other, in ſuch manner that the one *cannot* be excited without the other; for example, the nerves which terminate in the muſcles of the eyes, are diſtinct nerves, and diſtributed to parts diſtant from each other; yet, whenever, by volition, one eye is raiſed upwards, the other is raiſed alſo; which proves that the nerve which ſupplies the elevator which raiſes one eye, is connected with the

nerve which excites the muſcles to elevate the other; and that one naturally cannot receive excitement from the brain, without the other. That it is not owing to the nerves ariſing in pairs, or being ſimilarly excited, as paſſing to correſponding muſcles, is very evident, from this, that the muſcles which are excited to move the pupil of one eye *towards* the noſe, invariably act with the muſcles which move the pupil of the other eye, *from* the noſe; conſequently, in this caſe, the nerve which ſupplies the adductor muſcle of one eye, communicates ſo intimately with the nerve ſupplying the abductor of the other, that whenever the brain by volition excites a flow of the æthereal and phlogiſtic powers to the one, an equal proportion at the ſame time flows to the other.

It is not in the eyes alone, that ſuch nervous connexions take place; for even the nerves which ſupply the voluntary muſcles of the diſtant extremities, may be ſo connected at their origin as to act invariably with each other. In moſt people the nerves which ſupply the muſcles of the fingers of the right hand, have no particular connexion with thoſe of the left; and the volition which excites the right hand muſcles to act, flows to thoſe muſcles without any ſuch flow of powers, neceſſarily paſſing to the ſimilar nervous fibres of the left; but there are inſtances of people who from their infancy never could open or ſhut one hand, without an involuntary action of the muſcles of the other hand to open or ſhut it alſo; neither can they move any finger or joint, of one hand, without the ſimilar finger or joint of the other being moved in the ſame manner: it is evident, then, that the nerves diſtributed to one part may ſo communicate with nerves ſent to another, that the excitement of the brain imparted to one is directly communicated to the other.

12. Whether the voluntary nerves communicate with the involuntary nerves in the brain, or betwixt the brain and ganglia, or ſend branches to the ganglia themſelves, is, in general, the ſame in effect; for if an additional flow of powers to the ganglia is tranſmitted by means

of the excitement of the voluntary nerves, that is what is neceſſary; as the powers will then diffuſe themſelves to every part, to which the involuntary nerves are diſtributed, from the ganglia receiving the powers derived from the excited nerves of volition.

From the preceding conſiderations the following general concluſions may be drawn:

1ſt. That all the voluntary nerves ſend off branches to the ganglia of the intercoſtal nerves.

2d. That whenever by the excitement of volition, the æthereal and phlogiſtic powers are tranſmitted from the brain, by the voluntary nerves, to produce the action of the voluntary muſcles, a *proportionate* flow of thoſe powers is communicated by thoſe branches to the *ganglia* of the *intercoſtal nerves*: conſequently,

3d. That the involuntary muſcles, to which the intercoſtal nerves are diſtributed, muſt receive a flow of the æthereal and phlogiſtic powers from the voluntary nerves, whenever they are excited, and in proportion to the voluntary actions they produce ;—ſo that,

4th. The actions of the heart, &c. are, at all times, increaſed by voluntary exertions, and in proportion to the degrees of thoſe exertions, or actions.

5th. That involuntary, or poſterior faſciculi of the ſpinal nerves, are ſo intimately connected with the anterior or voluntary fibres of thoſe nerves, that the powers excited by volition to flow along the voluntary nerves, are partly communicated to the involuntary nerves accompanying them ;—conſequently,

6th. That the involuntary actions of the ſanguiferous veſſels of a voluntary muſcle, are always increaſed, by the powers exciting that voluntary muſcle to act, and in proportion to the degree of action : therefore,

7th. That the heart and involuntary muſcular fibres of the blood veſſels, thus receiving an additional flow of the æthereal and phlogiſtic powers, in proportion to the flow of thoſe powers to the voluntary muſcles, muſt be more powerfully and repeatedly *excited* to contract, by the *blood* to whoſe influence their nerves are expoſed; and, conſequently,

8th. That the blood, by the increaſed actions of the heart and blood veſſels, muſt be circulated through the ſyſtem with a velocity, increaſed in proportion to the degree of voluntary action; —and,

9th. That the rapidity of the circulation of the blood through a voluntary muſcle in action, muſt ſtill exceed the general velocity of circulation; becauſe, the voluntary nerves of that muſcle, beſides the general communication to the intercoſtal nerves, have a particular connexion with the involuntary nerves accompanying them to the muſcle itſelf; and, therefore,

10th. That the quantity of blood circulated through the ſyſtem, or to any voluntary muſcle, is naturally, proportionate to the quantity that is required there, to ſupport the actions of the muſcular fibres; to the production of which muſcular actions its preſence is ſo eſſentially neceſſary.

SECTION X.

A general view of the nervous and ſanguiferous ſyſtems, particularly with reſpect to their mutual dependance upon, and co-operation with, each other.

1. FROM what hath been already advanced, it is evident that the brain derives all its powers from the blood, tranſmitted to it from the heart; and it is equally certain that the contracting power of the heart is derived from the nerves, which convey it from the brain; ſo that the functions of the brain and nerves, depend upon the ſupply of blood from the heart and arteries; and the actions of the heart and arteries, in their turn, depend upon ſupplies of the two powers from the brain and nerves.

2. When the heart propels its blood to the

brain, that very blood excites the brain to exerciſe its functions :—that blood conveys the æthereal and phlogiſtic powers, which are ſeparated by the cerebrum and cerebellum ; and every new acceſſion of blood, excites the brain to diffuſe its ſecreted powers, by their reſpective nervous fibres to every part of the body.

3. So long as the brain keeps receiving due ſupplies of blood, of proper qualities, ſo long it keeps ſeparating from that blood the æthereal and phlogiſtic powers ; which as conſtantly diffuſe themſelves along the nerves to every part.

4. The powers thus conſtantly ſeparated by the brain, and *diffuſing* themſelves along the nerves, are *not* in an excited ſtate ;—they flow by ſimple diffuſion ; without the vital or animating powers of the brain, or nerves, being excited ; and, conſequently, without the power of flowing from the nervous extremities, or of aſſuming an atmoſpheric ſtate. It is the *ſimple flow* of fluids tending to an *equilibrium* ; for, as the

brain is conſtantly *receiving* freſh ſupplies of powers from the blood, theſe powers muſt *diffuſe* themſelves into all the nerves, but particularly *thoſe* which are the moſt *exhauſted,* to prevent an undue accumulation in the brain.

5. The æthereal and phlogiſtic powers, then, *conſtantly flow* to all the nerves connected with the brain, whether voluntary, or involuntary; but that is the flow of ſimple *diffuſion,* without the vital or animating excitement; and the nerves thus become ſupplied with their reſpective powers which conſtitute their *excitability* :—for, if the excitement of *volition* be communicated from the brain to a voluntary nerve, that excitement inſtantly gives progreſſive motion to the powers, which flow from their extremities in an excited ſtate, to the muſcular fibres, and cauſe them to contract; or, if a *ſtimulus* be applied to the vaſcular expanſions of the involuntary nerves, the powers diſtributed to thoſe nerves will be inſtantly excited to flow from the nervous extremities, proceeding from thoſe vaſcu-

lar expanſions of the nerves, to the fibres of the involuntary muſcles, and will cauſe them to contract.

6. So long, therefore, as the brain is ſupplied with *blood* of proper qualities, ſo long will the nerves convey the *æthereal* and *phlogiſtic* powers to the *heart* and *vaſcular extremities*; and ſo long as the blood is ſupplied with atmoſpheric air and proper food, ſo long will the heart contract, by the ſtimulating effects of the blood, thus duly ſupported, acting upon the powers tranſmitted from the brain to the nerves of the heart and blood veſſels: ſo long will all the involuntary muſcular fibres be excited to perform their due actions; and ſo long will the voluntary nerves be ready to execute the volitions of the mind, by having powers wherewith to excite the voluntary muſcles to contract, with the aſſiſtance of the blood duly ſupplied to thoſe muſcles by the actions of the involuntary muſcles.

7. The functions of the brain and nerves,

of the heart and blood veſſels, of the muſcular fibres voluntary and involuntary, and of every organ compoſed of thoſe diſtinct and eſſential parts, in an healthy animal, will be duly performed, ſo long as the *blood* is duly ſupplied with *pure air* and *proper food*, but *no longer*.

8. It is not the pureſt air, the moſt generous food, nor the richeſt cordials, that, *ſingly* applied, can ſupport the functions of the living body: it is not the *acid* principle in its pureſt ſtate, nor the *antacid* principle in its greateſt purity, that can enable the blood to ſupport the functions of the living man; it is the acid principle, rendered *aeriform* by its atmoſpheric arrangement of the *æthereal power*, and the antacid principle, with its *phlogiſtic power* in certain proportions and ſtates of combination, which, *together*, can ſupport the living powers, and they only:—for if the blood be not duly ſupplied with *both* theſe principles and powers, it cannot long excite the powers in the nerves, to produce the involuntary actions, neceſſary for

its tranſmiſſion to the brain; and when the exhauſted blood does arrive at the brain, it can no longer ſupply thoſe powers which the nerves require from the brain, to enable them to produce the contractions of the muſcular fibres; without which, the circulation muſt ceaſe, and all the functions of life depending upon it.

Since, then, conſtant ſupplies of pure air and proper food are neceſſary to ſupport life, the body muſt be ſo conſtituted as to render thoſe ſupplies deſirable; and ſuch muſcular exertions as are neceſſary to their acquiſition and application to the blood, muſt be excited in conſequence of their *deficiency* in the ſyſtem.

9. Such in reality is the caſe; the *deficiency* of *pure air* is productive of a *deſire* to *breathe* pure air, and excites the muſcles which expand the *thorax*, by which the air ruſhes into the lungs, and imparts its influence to the blood: and the *deficiency* of proper *food* produces the *ſenſation* of *hunger*, and excites ſuch muſcular exertions

as are neceſſary to procure proper aliment, and convey it to the ſtomach.

The next ſubject of inveſtigation, therefore, ſhall be reſpiration.

SECTION XI.

On reſpiration, or the manner in which the muſcles, ſubſervient to the expanſion of the thorax, are excited to act, in conſequence of a deficiency of pure air in the blood.

1. RESPIRATION is a complex operation, in which many muſcles are concerned:—what thoſe muſcles are it is not eſſential to my ſubject to particularly explain. My particular object, at preſent, is to ſhow in what manner the *dilation* of the thorax is neceſſarily produced, for the purpoſe of ſupplying the blood with air.—The muſcles of inſpiration, or thoſe which enlarge the dimenſions of the thorax, are then the only muſcles under conſideration; and they, indeed, are the muſcles chiefly concerned in natural reſpiration; for when their actions ceaſe, the parts forming the thorax will

return to their previous ſtates, ſo as to expel part of the air from the lungs, without any muſcular exertion being eſſentially neceſſary.

2. The muſcles, then, whoſe actions are particularly the ſubject under conſideration, are chiefly the diaphragm, and the intercoſtals; when theſe muſcles are excited to contract, the capacity of the thorax is enlarged, and the air ruſhes into the lungs, to diſtend them, ſufficiently, to ſtill fill up the cavity of the thorax, though enlarged:—this I call inſpiration;—theſe I call the muſcles of inſpiration; and, ſometimes for conveniency, the muſcles which expand the lungs, without contending for the propriety of the expreſſion.

3. When theſe muſcles ceaſe to act, the thorax is inſtantly contracted in its dimenſions, by the parts returning to their natural or uſual ſtate; in conſequence of which the expanded lungs will be compreſſed, and a volume of air will be expelled by this compreſſion, equal to what was taken in to expand them, when the thorax was

dilated: this I call expiration, without taking into account thoſe muſcles which may, particularly on preſſing occaſions, aſſiſt in the diſcharge.

4. The muſcles of inſpiration are ſubject to the will, at leaſt to a certain extent; becauſe their actions may be accelerated, or retarded by volition; but when not controlled by the will, they act involuntarily, and, in general, inconſciouſly.

5. But theſe actions are the ſame, and the effects the ſame, whether they be involuntarily or by volition; conſequently, theſe actions are produced by the ſame means in both caſes.

6. We know that a voluntary muſcle is made to act, by the two powers being excited to flow along the nerves to the muſcular fibres: the muſcles of inſpiration, then, being ſubject to the will, muſt be made to act by the powers being excited to flow along the nerves to thoſe muſcles:—but as their actions are the ſame

whether they be excited by volition, or involuntarily, it muſt follow, that theſe muſcles of inſpiration are, in all caſes, thrown into action by the æthereal and phlogiſtic powers of the nerves, ſupplying theſe muſcles, being excited to flow along their nervous fibres; and not by the ſtimulus of the blood acting on their extremities, as is uſual in other involuntary actions.

7. When the muſcles of inſpiration act, air ruſhes into the lungs, and their action *ceaſes*, if that air be pure; but, if *no air* be admitted to the lungs, or that air be *impure*, their *actions continue*, or are quickly *repeated*; and thoſe actions, or a tendency to act, continues with pain and anxiety, till pure air is admitted, or till the functions of the ſyſtem are impaired.—If, again, pure air *be* admitted, the actions of the muſcles of inſpiration *ceaſe*; till the air, remaining in the lungs, becomes impure, and freſh ſupplies of pure air be wanted.

8. It is evident, then, that it is *not* the pure air which excites the muſcles of inſpiration to

act; becauſe, when it is received into the lungs, their action *ceaſes:* but, it is the *want* of pure air which gives riſe to the excitement of the nerves, which cauſes thoſe muſcles to act, as is evident from the violent and quickly repeated efforts to inſpire, when pure air is not admitted to the lungs, to remove that cauſe which keeps up the excitement of the nerves of thoſe muſcles.

9. When the muſcles of inſpiration act, then, the powers of the nerves ſupplying thoſe muſcles are *excited*; when *air* is admitted into the lungs, that *excitement* of thoſe nerves *ceaſes*; if pure air be *not* admitted, the excitement is *kept up* with anxiety and pain, till the natural functions of the ſyſtem are impaired.

10. Pure air, then, when admitted into the lungs, *removes* the excitement of the powers of the nerves ſupplying the muſcles of reſpiration; and, when pure air is *not* admitted into the lungs, the excitement of theſe nerves *increaſes:* it is evident, therefore, that the excite-

ment of the nerves ſupplying the muſcles of inſpiration, depends upon the ſtate of the lungs.

11. But, that ſtate of the lungs cannot communicate its influence to the nerves of the muſcles of inſpiration, by means of the blood; becauſe, that communication is inſtantaneous:—conſequently, then, it muſt be the *nerves* diſtributed to the lungs which communicate their influence to the *nerves* of the muſcles of inſpiration; and upon the ſtate of thoſe nerves of the lungs, the excitement of the nerves of the muſcles depends.

12. The muſcles of inſpiration act when the powers are excited to flow along their nerves. If pure air be not admitted to the lungs, that flow of excited powers to the muſcles is increaſed:—by what?—by the influence of the nerves of the lungs:—then, when the nerves of the lungs are *not* ſupplied with pure air, they *increaſe* the excited *flow* of the powers of the nerves belonging to the *muſcles* of inſpiration.

If pure air *be* admitted to the nerves of the lungs, the flow of excited powers to the muſcles of inſpiration *ceaſes:* conſequently, then, the pure air *takes away* from the nerves of the lungs *thoſe powers,* which, when *not* diſcharged from thoſe nerves of the lungs, are *communicated* to the nerves which ſupply the *muſcles of inſpiration,* and cauſe them to contract.

13. The nerves of the lungs, then, conſtantly receive a flow of the æthereal and phlogiſtic powers from the brain; when thoſe powers *accumulate* to a certain degree, they *flow* to the *nerves* which ſupply the *muſcles* of *inſpiration,* and cauſe them to *act*; by their action, the lungs are expanded by pure air; that air *diſcharges* the nerves of the lungs of their powers; and by that diſcharge the collateral *flow* to the nerves of the *inſpiratory muſcles* ceaſes, and they *ceaſe* to act:—but as the flow of the nervous powers to the lungs is conſtant, if pure air be denied, the powers will be accumulated in thoſe nerves to a certain degree, when the reſt will totally paſs to the nerves of

the muſcles of inſpiration, and excite them to violent and repeated actions, either till pure air be admitted to diſcharge the nerves of the lungs, or till the functions of the nerves are deſtroyed by the want of æthereal power in the brain.

14. For what purpoſe is this conſtant and copious flow of the nervous powers to the lungs, and which are the nerves which convey them? —The nerves which are chiefly diſtributed to the lungs are the *par vagum*, with ſome branches from the intercoſtals, occaſionally interwoven. If we cut theſe nerves, then, the effects they are deſtined to produce will be diſcovered by the want of them.

15. If the par vagum and intercoſtals be cut, reſpiration inſtantly becomes laborious and difficult; in a ſhort time, the animal dies, and the lungs are found *loaded with blood.*

16. It appears, then, that the nerves of the lungs are for the purpoſe of keeping up the

vaſcular actions there; of ſuch vaſt importance to man! ſince, as much blood paſſes through the lungs in any given time, as through all the arteries in the reſt of the body.—The par vagum, then, is diſtributed to the lungs, and particularly to the pulmonary arteries and veins, to cauſe them to contract and propel the blood from the right to the left ſide of the heart; for when thoſe nerves are cut, the pulmonary veſſels are no longer excited by the blood, ſufficiently, to promote its tranſmiſſion through them.

17. It is obſervable, that the reſpiration becomes laborious, as ſoon as thoſe nerves are cut. Why? Becauſe the *powers* which naturally flowed along the par vagum, and were *diſcharged* in producing the vaſcular actions of the lungs, now *cannot flow* along thoſe nerves, further than the extremities where they were cut; conſequently, as the nerves of the muſcles of inſpiration are connected with them, *thoſe powers* muſt *flow* to the *muſcles* of *inſpiration*, in unuſual proportions, and diſcharge

themſelves there, by producing deep and unnatural actions of thoſe muſcles, till the ſupplies of thoſe powers from the brain fail, and death enſues.

18. The branches of the par vagum, diſtributed to the lungs, then, keep up the actions of the pulmonary veins and arteries; particularly their minute ramifications in the bronchial cells:—but thoſe actions are involuntary; conſequently, thoſe pulmonary branches of the par vagum muſt be *interwoven*, upon the *ſurfaces* of the *pulmonary veins* and *arteries*, ſo as to form a nervous or medullary plexus, like the other involuntary nerves; and thoſe nervous expanſions muſt be ſtimulated to excitement by the blood; which excitement being conveyed to the muſcular fibres of thoſe veſſels, by the nervous fibrillæ diſtributed from thoſe expanſions to the muſcular fibres, will cauſe them to contract, in the ſame manner as other involuntary muſcles are made to contract.

19. The par vagum, then, conveys the

æthereal and phlogiſtic powers to the lungs; when there, thoſe powers are excited by the blood, and with the aſſiſtance of the æthereal and phlogiſtic powers in the blood, produce the vaſcular actions of the lungs, by which the blood is propelled through them to the left auricle and ventricle of the heart.

20. But, as has already been conſidered and explained, (ſect. vii.) the nerves convey both the æthereal and phlogiſtic powers to the muſcles: they require the *blood* to be replete with *both* thoſe *powers* to aſſiſt in producing muſcular action; and the blood muſt contain *both* thoſe powers, to enable it to *excite* the *nerves* expanded upon the ſurfaces of the *blood veſſels*, ſo as to produce the involuntary actions of thoſe veſſels.

21. The blood which paſſes from the right ſide of the heart to the vaſcular extremities of the lungs, is naturally conſiderably exhauſted, or nearly deprived of its acid principle and æthereal power:—that blood, then, can neither

excite the nerves expanded upon the ſurfaces of the blood veſſels, nor enable the powers of the nerves to produce contraction of the involuntary muſcular fibres, with any degree of vigour; becauſe it *wants* the *æthereal power* to co-operate with the phlogiſtic power which it contains.

22. In health, then, the æthereal and phlogiſtic powers flow by the par vagum to the lungs:—thoſe nerves are expanded upon the ſurfaces of the pulmonary veins and arteries, and are expoſed to the influence of the blood; that blood having been exhauſted of its æthereal power, in paſſing through the ſyſtem, cannot excite thoſe nerves to diſcharge themſelves to the muſcular fibres of thoſe veſſels, for *want* of the *æthereal power* to co-act with the phlogiſtic power.—In this ſtate, the nerves *not* being excited to *diſcharge* their powers, and the powers ſtill conſtantly flowing to them from the brain, *thoſe powers* muſt be *accumulated* in thoſe nerves of the lungs;—in conſequence of that accumulation, the *redundant powers* are *commu-*

nicated to the *nerves* of the *muſcles* of *inſpiration*, by connecting branches:—the powers thus communicated *flow* to thoſe *muſcles*:—they contract; the thorax expands: pure air ruſhes into the lungs: the *æthereal power* thus ſupplied to the *blood*, it immediately excites the *nerves* of the *lungs*: they diſcharge their powers to the *muſcular fibres* of the *veſſels*: thoſe muſcles act and propel the blood to the heart; while the nerves of the lungs, being *diſcharged* of their powers, the tranſmiſſion of thoſe powers to the nerves of the muſcles of inſpiration, in conſequence of their redundance, *ceaſes*, and thoſe muſcles ceaſe to act, till the arrival of more blood deprived of æthereal power to the bronchial cells; in which caſe, the powers of the nerves of the lungs will again want excitement, and diſcharge; will again accumulate, and flow to the muſcles of inſpiration; and will again, by cauſing thoſe muſcles to act, procure the admiſſion of pure air to the blood; without which the actions of the lungs, as well as of the heart, brain, and every part of the ſyſtem, muſt ceaſe.

23. It is evident, then, that the phlogiſtic power in the blood cannot, *alone*, excite the involuntary nerves: that for want of excitement, the powers accumulate in the nerves of the lungs; and that the powers thus accumulating are wiſely communicated to the muſcles of inſpiration; by whoſe actions, the blood is ſupplied with that æthereal power which is wanting.

24. Another ſubject of conſideration reſpecting the lungs now preſents.—As the blood which is diſtributed to every part of the body muſt paſs through the lungs, to receive the æthereal air, and as the quantity circulated through the ſyſtem in any given period is increaſed in proportion to the muſcular actions of the ſyſtem, voluntary or involuntary, of neceſſity, the parts muſt be ſo conſtituted, that the *degree* of *action* of the vaſcular extremities in the lungs, ſhall, at all times, be proportionate to the actions of the reſt of the ſyſtem.—That this in reality is the caſe is evident to every obſerver; for, if the involuntary actions of the heart and

blood veſſels be quickened, the actions of the lungs are more frequent; if the voluntary muſcles be put into action, the reſpirations inſtantly become more quick and full; and if even a hand or a foot be *rigidly* ſtretched out, the breathing will be repeated at ſhorter intervals, in conſequence.

25. It is very evident, then, that the nerves called the *par vagum* are connected with *every nerve*, voluntary or involuntary: it is very probable that they are formed of *branches* diſtributed from *every* diſtinct nerve; which branches, compacted together, form the par vagum, or eighth pair, ariſing from the baſis of the brain; or, rather, ariſing from the more *interior* parts of the brain, where the numerous connexions with the other nerves can be more conveniently made: and it is very evident, that the fibres of the par vagum which paſs to the *lungs*, after being thus formed by the other nerves, communicate *within* the brain, with the nerves which ſupply the *muſcles* of *inſpiration*.—In conſequence of thoſe connexions, it muſt follow,

that whenever the æthereal and phlogiſtic powers flow from the brain to any nerve, voluntary or involuntary, a *portion* of thoſe *powers* muſt paſs to the par vagum and to the *lungs*; conſequently, whatever be the *degree* of muſcular exertion in the ſyſtem, the lungs will be made to receive an *equal* flow of thoſe powers, to ſupport their actions;—and the more *copious* that flow of powers to the lungs is, the ſooner they will *accumulate* and regurgitate, or flow into the nerves of the *muſcles* of *inſpiration*, to expand the lungs, and admit pure air, for the purpoſe of exciting the nerves of the lungs to *diſcharge* themſelves in *vaſcular actions*; by which the blood, repleniſhed with the *aerial* influence, may be tranſmitted to *every* part of the ſyſtem, in proportion to the neceſſity there is for it there, to ſupport the muſcular actions.

26. That the nerves of the lungs *do* receive the powers from *every nerve*, diſtinctly, by a communicating *branch*, is abundantly evident from this, that, no *ſingle* muſcle can act, but the actions of the lungs are immediately *in-*

creaſed:—if one hand be firmly cloſed for a minute, the number of inſpirations in that minute will be *greater* than before, *cæteris paribus*: conſequently, *every* nerve, ſupplying any muſcle, *muſt* ſend a branch to the *par vagum*, as well as to the intercoſtal nerves, as was before explained, ſect. ix.

27. The par vagum, then, certainly do receive a proportion of the æthereal and phlogiſtic powers, from every nerve ariſing in, or from the brain:—they certainly alſo are connected with the nerves of the muſcles of inſpiration; and when a certain quantity of thoſe powers is received into the nerves of the par vagum, they paſs into the nerves of thoſe muſcles, and excite them to contract; by which the lungs are made to receive the air:—if the *diſcharge* of thoſe powers from the nerves of the lungs be *prevented*, *entirely*, that accumulation of powers will be more ſpeedy and great, and the flow of powers to the nerves of the lungs will be entirely *diverted* to the *muſcles* of *inſpiration*

28. That a portion of the powers may *regularly* flow from the par vagum to the nerves ſupplying the muſcles of inſpiration, is poſſible; but, that the æthereal and phlogiſtic powers in the nerves of the lungs, when there is *not* pure air to enable the blood to excite them to diſcharge themſelves, by *accumulation*, flow to the nerves and muſcles of *inſpiration*, and cauſe them to expand the thorax, is inconteſtably evident; even from this *one* conſideration, that the admiſſion of pure air to the lungs, inſtantly *takes away* the *excitement* of the muſcles of inſpiration; and, if pure air be *denied* to the lungs, the flow of the exciting powers to the nerves and muſcles of inſpiration is *rapid* and *exceſſive*; that is, when the powers *cannot* be diſcharged from the lungs, they *paſs off* by the nerves to the muſcles of inſpiration: in ſhort, that the excitement of the nerves and muſcles of inſpiration is derived from the nerves of the lungs I have already proved in par. 9 and 10 of this ſection, and ſhall not further inſiſt upon what is ſelf-evident.

29. There is one obſervation to be made,

of ſome importance, which is this.—The nerves ſupplying the muſcles of inſpiration are ſubſervient to the will:—volition throws thoſe muſcles into action, by tranſmitting a flow of the æthereal and phlogiſtic powers from the brain along thoſe nerves; which flow is kept up by the *vital* or *animating* powers of the nerves correſpondent *to*, and excited *by* the *intellectual* powers of the brain, till thoſe æthereal and phlogiſtic powers are communicated to the material particles in muſcular arrangement in an *excited* ſtate; when, becoming atmoſpheric around thoſe muſcular particles, they attract them together, by means of the powers in the blood, as before more particularly explained.—The *ſame flow* of powers, then, is tranſmitted to the muſcles of inſpiration when they act *involuntarily*; conſequently, when the æthereal and phlogiſtic powers are *not* diſcharged from the nerves of the lungs, for want of pure air, and become *accumulated* in thoſe nerves, till they flow to the nerves of the muſcles of inſpiration by the communicating branches, *thoſe powers*, thus flowing to the nerves of the muſcles of inſpiration, excite the *vital,* or *animating* powers of thoſe nerves to tranſmit them to the muſcular fibres, and cauſe them to act; conſequently, whether the flowing powers excite the vital or animating principles of the nerves, or thoſe principles be excited to give motion to the powers, ſtill the effect is the ſame; and the excitement of the vitality or animation of a nerve, and the progreſſive motion of its æthereal and phlogiſtic powers are *ſimultaneous* and *mutually* productive of each other.

30. That the nervous powers may be excited to flow along the nerves, in *unuſual quantities*, is evident in various parts of the ſyſtem, on different occaſions; and that thoſe powers may accumulate in thoſe nerves, and *regurgitate*, as it were, into other nerves, ſo as to excite them to act, is not peculiar to the nerves of the lungs alone:—for example, if the nerves of the membrane which is expanded within the noſe, called, commonly, Schneider's membrane, be *ſlightly irritated*, the æthereal and phlogiſtic powers will flow in an increaſed quantity and excitement, and will *diſcharge* themſelves, in exciting the

muſcular actions of the *vaſcular extremities,* to an *unuſual degree*; by which means, the natural ſecretions performed by thoſe veſſels will be greatly *increaſed,* and poured out upon the ſurface of the membrane.

If this ſtimulus upon the nerves be *increaſed,* the flow of æthereal and phlogiſtic powers to thoſe nerves will be ſo rapid and *copious,* that they *cannot* be *diſcharged* by means of the muſcular fibres and the blood circulating with them; the powers then *accumulate,* and flow to the nerves ſupplying the muſcles of the *trunk*; which muſcles they throw into the violent actions, which we call *ſneezing*; an effect ſo well adapted to remove the ſtimulus which thus violently excited the powers to flow. Whether the excited powers paſſed from the naſal nerves to the nerves of the muſcles thus thrown into action, by collateral branches, communicating from the naſal nerves to the other, or they excited the brain to tranſmit the powers to thoſe muſcles by their reſpective nerves, is of no conſequence to determine.—That the naſal nerves, when highly excited, produce a violent flow of powers to the *muſcles* exerted in *ſneezing*, is evident; that the naſal nerves have a *peculiar connexion* with the nerves of thoſe muſcles, is certain; becauſe the excitement of the naſal nerves does *not* affect the muſcles of the *extremities*, but thoſe concerned in ſneezing *only*: in what part of the brain thoſe nerves are connected, then, is *immaterial*, ſo long as we know, to a certainty, that they are *peculiarly* connected with each other.

31. That the powers actually *regurgitate*, or paſs from the naſal nerves to the nerves of thoſe peculiar muſcles, when they accumulate in the naſal nerves to a certain degree, is probable; becauſe a *ſlight* augmentation of that flow of powers to the naſal nerves, inſtantly produces *increaſed vaſcular* action or ſecretion in the noſe, which *diſcharges* thoſe powers from the nerves without affecting the muſcles; and it is only when the powers are excited to flow to the naſal nerves more rapidly than they *can diſcharge* them, that they paſs to the nerves of the

muſcles connected with them, and by diſcharging themſelves from thoſe nerves, produce the violent contraction of the muſcles which conſtitutes ſneezing.

32. It is very evident, likewiſe, that *one nerve* may, and does, in many inſtances, communicate a *portion* of its æthereal and phlogiſtic powers to *another nerve*, by a communicating branch, although the *other cannot*, in return, impart a portion of its powers to the *former*; for in the caſe of the naſal nerves, we know that when they are excited, they can communicate a flow of powers to the nerves cauſing the muſcles to act in ſneezing; but *no flow* of powers along the nerves diſtributed to *thoſe muſcles*, nor any kind or degree of excitement or irritation of *them*, will be communicated from them to the *naſal nerves*, ſo as to produce either ſneezing, or any direct increaſe of their actions, or of the ſecretions effected by thoſe actions.

33. The par vagum, then, in many circumſtances, greatly *reſemble* the intercoſtal nerves;

each receives a portion of the powers flowing from the brain by any nerve; becauſe every nerve ſends off a communicating branch to both; and both are diſtributed to the involuntary muſcles; in conſequence of which, the involuntary actions muſt always be proportionate to the general degree of action in the ſyſtem.

34. The par vagum *differ* from the intercoſtal nerves in this reſpect,—the branches from the voluntary nerves paſs into *ganglia* in the *intercoſtals*, before they are diſtributed to the involuntary muſcles, or vaſcular extremities; and the nerves paſſing to the vaſcular extremities of diſtant muſcles, paſs through ganglia, which render them involuntary and cut off every direct communication between the brain and thoſe muſcular parts;—but, on the contrary, the par vagum do *not* paſs through ganglia; they ariſe from the nerves directly communicating with the brain, and convey their powers, *uninterrupted*, to the parts to which they are diſtributed.

35. As the par vagum do not ariſe directly from the ſenſorium, they are *not* ſubject to *volition*; they only receive a *portion* of *all* the powers which do flow from the brain to *all* or *any other nerves*:—neither can the powers they receive, immediately excite muſcular action; becauſe the branches of the par vagum are expanded upon the *ſurfaces* of the veſſels, in the manner of complicated medullary plexuſes; there the powers *ſtop* in their courſe, till they are *excited* by the *ſtimulus* of the *blood*; when they flow along their reſpective fibrillæ, diſtributed from thoſe expanſions on the veſſels, to the muſcular fibres; which, with the aſſiſtance of the powers in the blood, they cauſe to contract.

36. From the preceding conſiderations, I draw the following general concluſions:

1ſt. That the par vagum, or eighth pair of nerves, are formed of branches ſent off from *every* diſtinct nerve, originating in the *brain*;

which branches, collected together, conſtitute the par vagum.

2d. That whatever be the *quantity* of æthereal and phlogiſtic powers, flowing from the brain, to any, or all of the nerves, a *certain proportion* of thoſe powers is neceſſarily tranſmitted to the *par vagum*, by thoſe collateral *branches* of which they are formed; conſequently,

3d. That the *actions* of thoſe parts to which the par vagum are diſtributed, muſt, neceſſarily, at all times, be proportionate to the actions of the ſyſtem in general.

4th. That conſiderable branches of the par vagum are diſtributed to the *lungs*, and expanded upon the *ſurfaces* of the *vaſcular extremities* there, ſo as to be expoſed to the action of the blood, and the air alſo, in the bronchial cells.

5th. That the nerves, thus expanded, receive the æthereal and phlogiſtic powers conſtantly flowing from the brain, in ſome proportion or other; and, that thoſe nervous powers, when excited by the blood, replete with phlogiſticated food and æthereal acid, immediately flow along the nervous fibrillæ to the muſcular fibres, and cauſe them to act; by which, the blood they contain is propelled from the right ſide of the heart, through the lungs, to the left; and the nerves are *diſcharged* of their powers for that time.

6th. That the blood flowing from the heart by the pulmonary *arteries*, being nearly *exhauſted* of its *æthereal* acid, *cannot* excite the nerves expanded on the vaſcular extremities of the lungs, to flow and *diſcharge* themſelves along the muſcular fibres of thoſe blood veſſels.

7th. That the *powers*, thus conſtantly flowing to the nerves of the lungs, from which they are not duly excited to diſcharge themſelves, on account of the *want* of the *æthereal* acid of the air, muſt ſoon *accumulate*, ſo as to prevent any further flow of thoſe powers to the lungs.

8th. That the powers thus accumulated in the nerves of the lungs, do, then, flow by a *lateral* communication to the nerves, diſtributed to the *muſcles* ſubſervient to *inſpiration*.

9th. That by that flow of powers, the muſcles which dilate the thorax are made to act; and the air ruſhes into the lungs, and imparts its influence to the nerves and blood in the bronchial cells.

10th. That the *pure air*, thus received into the lungs, imparting its influence to the *blood*, reſtores to it that *æthereal power* which was wanting; and the nerves of the lungs are, therefore, inſtantly excited to tranſmit their powers to the muſcular fibres of the blood veſſels; in conſequence of which, the blood is propelled through thoſe veſſels towards the left ſide of the heart; and the nerves of the lungs are *diſcharged* of their powers.

11th. That the nerves of the lungs being thus diſcharged, the collateral flow to the nerves and muſcles of *inſpiration* will be *ſtopped*, and their actions will *ceaſe*.

12th. That the air thus received into the lungs, muſt ſoon be *deprived* of its *æthereal* acid, by the flowing blood exhauſted of its æthereal power by ſupporting the actions of the muſcles in its circulation through the ſyſtem; and, conſequently, that the *ſucceeding* blood will *not* be capable of exciting the nerves to diſcharge themſelves in producing the vaſcular actions of the lungs:—the circulation of the blood will be impeded; the powers of the nerves will accumulate; they will then regurgitate, or flow to the nerves and muſcles of inſpiration; *thoſe muſcles* will be thrown into *action*, and air will, *again*, be received into the lungs, and will diſcharge the nerves; promote the circulation of the blood, and *ſuſpend* the flow to the muſcles of *inſpiration*, which will again *ceaſe to act* as before.

13th. That if pure air be *not* admitted to the lungs, the nerves will *not* be excited to *diſcharge* their powers along the muſcular fibres of the pulmonary veſſels; thoſe veſſels will not be capable of *propelling* the blood; the powers prevented from flowing off by the nerves of the lungs will be accumulated; and the ſucceeding powers flowing from the brain will entirely paſs to the nerves and *muſcles* of *reſpiration:* in conſequence of which, their actions will become *conſtant* and *exceſſive*; till the *brain itſelf*, being deprived of its conſtant ſupplies of æthereal power, from the blood tranſmitted from the heart after paſſing through the lungs, will be ſo far *impaired* in its functions, as only to tranſmit its powers in occaſional convulſive jets; when, if the æthereal air be not admitted to the lungs, death itſelf muſt ſpeedily enſue.

14th. That, by the nerves of the lungs being thus formed from, or at leaſt receiving branches from, *all* the *other nerves* of *motion* in the ſyſtem, derived immediately from the brain, the powers tranſmitted to the *lungs* muſt ever be *proportionate* to the powers tranſmitted to excite the muſcular actions of *every other* part of the ſyſtem;

and, conſequently, the veſſels of the lungs will be rendered capable of tranſmitting as much blood, through the lungs, as is tranſmitted through all the muſcles in the other parts of the body.

15th. And that the nerves of the lungs thus communicating with the nerves of the muſcles of inſpiration, will impart a flow of the powers to them proportionate to the degree of excitement or muſcular action in the ſyſtem; becauſe the *more rapidly* the powers flow to the nerves of the lungs, the *ſooner* will they *accumulate*, and paſs to the nerves and muſcles of inſpiration, if not excited by the blood and æthereal air; and as the blood flowing through the lungs is naturally nearly *exhauſted* of its æthereal power, and flows with a rapidity proportionate to the general degree of muſcular action in the ſyſtem, the more rapidly that blood is ſent to the lungs, the more frequently muſt it require the admiſſion of pure air to reſtore the æthereal power, and enable it to excite the nerves of the lungs to diſcharge themſelves; conſequently, the more frequently the blood *wants* the *æthereal* power to excite the nerves of the lungs, the more repeatedly muſt the *powers* of *thoſe nerves* regurgitate to the nerves and muſcles of *inſpiration* to excite them to act; by which means the blood will acquire the æthereal power from the air, and diſcharge the nerves of the lungs, by exciting them to flow to the muſcular fibres, by whoſe actions the blood is circulated through the lungs to the heart.

By theſe means the *blood*, ſupplied with the phlogiſtic power from the food taken into the ſtomach, acquires the *æthereal power* from the *air*, and then becomes capable of exciting the nerves expanded upon the ſurfaces of the veſſels which convey it, to tranſmit thoſe powers to the involuntary muſcles, and cauſe them to act; by which actions the *blood* is circulated to every part.

To the brain and nerves it imparts its æthereal and phlogiſtic powers; and in the muſcles it is the *medium* by which thoſe powers, excited to flow from the nerves, are enabled to *attract* the particles of matter in *muſcular arrangement,* together, ſo as to produce what we generally call the *action* or *contraction* of the *muſcles* ; by which attraction alſo, the æthereal and phlogiſtic powers combining together, form *animal heat* ; which, at all times, is, therefore, proportionate to the muſcular actions of the ſyſtem.

But, the blood requires frequent ſupplies of *phlogiſton,* as well as of the æthereal power ; in conſequence of which, *proper food,* containing the *phlogiſtic power,* is as neceſſary as pure air ; the next conſideration, therefore, is—The digeſtive powers of the ſtomach and inteſtines, by which the blood is ſupplied with the phlogiſtic power combined with the antacid principle.

SECTION XII.

On the digeſtive powers of the ſtomach; and the manner in which the appetite for food is excited, in conſequence of a deficiency of the phlogiſticated principle in the blood.

1. IT has already been obſerved, (ſect. ii. and iii.) that the reception of proper food into the ſtomach, is as neceſſary to ſupport the functions of the brain, and the ſanguiferous and muſcular actions, as the admiſſion of proper air into the lungs is; and, that nothing is capable of affording proper nouriſhment, but what does contain the *phlogiſtic power* in a ſtate of ſlight combination, and in a greater proportion than the æthereal power.

2. It has already been obſerved, (ſect. vii.) that all actions or motions in the ſyſtem, are effected by muſcular fibres: that muſcular fibres are made to contract by the powers of the nerves: —that the nerves convey both the æthereal and phlogiſtic powers; and that thoſe powers cannot,

naturally, be excited by the blood, to produce the involuntary actions of the ſyſtem, unleſs the blood itſelf *contains* both the *æthereal* and *phlogiſtic powers.*

3. It has likewiſe been obſerved, that the æthereal power is obtained from the air, in its ſtate of arrangement around the acid principle; and that the phlogiſtic power, when in proper ſtates for affording nouriſhment to the body, is combined with the antacid principle in ſome ſtate, or proportion, or other. The antacid principle, then, in thoſe ſtates of connexion with the phlogiſtic power, which are proper for nutrition, may be called, for the ſake of conveniency, the *phlogiſticated principle.*

Here let me obſerve, that *antacid principle* is the general term for the *contrary* to the *acid, principle,* whatever be its ſtate; and, therefore, it includes the carbon, azote, and hydrogen of the French ſchool, which are only *varieties* of the *ſame principle,* with *different* proportions of the *phlogiſtic* power.

4. By the wiſe contrivance of nature, the

world is ſo conſtituted that the antacid, alkaline, or earthy principle, with the phlogiſtic power, exceeds in proportion, the acid principle and its æthereal power, in general, in the animal, vegetable, and mineral ſyſtems; in all of which the *phlogiſtic power* particularly *abounds*, but is ſo complicated with the other power and principles, as to be condenſed into ſtates more or leſs ſolid, by chemical combination; on the contrary, the *Atmoſphere alone*, is the grand and general ſource of *æthereal power*, and in few other ſtates do we meet with it in an over proportion: conſequently, the animal and vegetable kingdoms in particular, may afford numerous articles capable of ſupplying the blood with the phlogiſticated power, combined in various proportions with the other principles; but, *pure air, alone*, is capable of affording the æthereal power in ſuch a ſtate as is adapted to the lungs, and in ſuch proportion, as the blood requires to enable it to ſupport the functions of the brain, and to excite the two powers in the nerves.

5. As the *phlogiſtic power* is capable of being

combined with the material principles in *very great* proportions, and is commonly found in thoſe proportions in various ſubſtances, it is evident, that by means of certain aliments, the blood may be ſupplied with the phlogiſtic power in *great proportions* and quantities; and that this is the caſe, is abundantly evident from this ſingle conſideration, that a man, well fed and in good health, is capable of living and exerciſing all his functions, for ſeveral days, without any *freſh ſupply* of food to the ſtomach; he breathes, ſuppoſe about twelve or fourteen hogſheads of air in one day; the blood contains phlogiſtic power enough to combine with and ſaturate, or nearly ſo, *all* the *pure air* in that quantity of atmoſpherical air; conſequently, were he to live ſeven or eight days without food, the blood muſt have contained as much phlogiſtic power as would be ſufficient to ſaturate, or nearly ſaturate, *one hundred hogſheads* of *atmoſpherical air*; a great part of which would be changed into *fire* or *heat*, as in caſes of common combuſtion.

6. This being the caſe, the blood does not require ſuch *frequent* ſupplies of the phlogiſticated

principle, as it does of æthereal acid, or pure air; and we muſt now conſider in what manner the ſyſtem is excited to provide occaſional ſupplies of the phlogiſticated principle, when that principle is, to a certain degree, *exhauſted*; or when the phlogiſtic power begins to be deficient in the blood.

7. The *ſtomach* is the receptacle of the food which is taken to ſupport the ſyſtem; and the inteſtines, liver, pancreas, ſpleen, lacteals, meſenteric glands, &c. &c. are all employed in diſſolving the aliment; in ſelecting the nutrimental parts; in expelling the uſeleſs matters, and in conveying what is proper for the ſupport of the body to be mixed with the blood.

This proceſs is performed by means of various fluids, ſecreted by glands of different deſcriptions, and by various vaſcular actions in every part of the chylo-poietic viſcera.

8. The various, extenſive, and conſtant actions of the abdominal viſcera are *involuntary*,

and require a conſtant and copious ſupply of the *nervous powers* to perform them, and of *blood,* replete with the *æthereal* and *phlogiſtic powers* to excite them, and to aſſiſt in the action of the *muſcular fibres,* by which thoſe involuntary actions are performed.

9. The nerves which convey the æthereal and phlogiſtic powers to thoſe parts, are the *intercoſtals* and the *par vagum.* Both theſe pairs of nerves are chiefly, if not entirely, formed of *branches* ſent off from *all* the other *nerves of motion,* immediately connected with the brain: both of them receive a flow of the æthereal and phlogiſtic powers, in proportion to the *degree* of *action* in *any* or *every* part of the ſyſtem; and, conſequently, the actions of the ſtomach, bowels, &c. as well as of the heart and lungs, muſt correſpond with the degree of action in the ſyſtem.

10. That this is the caſe is too evident, from daily experience, to admit of a doubt; and it was wiſely ordained; for as the blood is exhauſted of its powers in proportion to the degree of action in the ſyſtem, the actions of the ſtomach

and lungs, by which thoſe powers are reſtored to the blood, muſt be, at all times, proportionate to the actions which expand them, otherwiſe diſorder muſt enſue; and the beſt means of keeping up that balance, was to ſo order it, that the very nerves which convey the powers of action to the muſcles of volition, ſhall *tranſmit* a *juſt proportion* of thoſe powers to the *nerves* which act for the purpoſe of *providing ſupplies* of thoſe powers to the ſyſtem at large.

11. The *vaſcular actions* of the ſtomach, inteſtines, liver, ſpleen, pancreas, lacteals, meſentery, &c. are very great and numerous; and the quantity of *nervous powers* neceſſary to perform thoſe various and extenſive actions, muſt be great indeed; conſequently, the quantity of *blood*, duly ſupplied with the æthereal and phlogiſtic powers, muſt be *conſiderable*, to afford *excitement* to thoſe nerves, ſo as to make them *diſcharge* their powers along the *muſcular fibres*, and cauſe them to *contract*.

12. As the proportion of æthereal and phlo-

giſtic powers flowing conſtantly to the nerves of the abdominal viſcera, muſt be great, and as thoſe powers are only excited to act by the *ſtimulus* of the powers in the *blood,* or *fluids* acting upon them in their ſtates of *expanſion* upon the *interior ſurfaces* of the blood veſſels, or glands, it is evident, that when the blood becomes *exhauſted,* to a certain degree, of its *phlogiſtic power,* it *cannot* excite the nerves to *diſcharge* their powers ſufficiently; in conſequence of which, the *vaſcular actions* of the abdominal viſcera will be *imperfectly* performed, and the circulation *impeded.*

13. When, therefore, the phlogiſticated principle becomes *deficient* in the blood, the actions, and ſecretions of the abdominal viſcera will be *diminiſhed.*

If, in this ſtate, any proper food, or phlogiſtic matter be taken into the ſtomach, that *phlogiſton* being applied to the nerves of the ſtomach, where the blood duly ſupplied with the æthereal power is preſent, will with the *conjoint influence* of that *æthereal power*, immediately *excite thoſe nerves* to tranſmit their powers to the *muſcular fibres*; and the *vaſcular actions* will be *reſtored* to their *due degree* of power and efficacy.

14. As the flow of *thoſe powers* to the nerves of the ſtomach is *conſtant*; as it is proportionate to the degree of action in the ſyſtem in general; and as the deſire for food is in proportion to the actions of the ſyſtem, it is evident, that the *ſenſation of hunger*, or the *deſire for food*, is produced by *thoſe powers* in the nerves, or by the *quantity* of *them* preſent; becauſe, the moſt *ardent deſire* for food may be immediately *extinguiſhed*, by taking *phlogiſtic* ſubſtances of certain kinds into the ſtomach; that is, the phlogiſton thoſe ſubſtances contain, with the æthereal power in the blood, together excite thoſe nerves to *diſcharge* themſelves.

15. It is clear, then, that when the phlogiſtic power is *deficient* in the blood, and the nerves of the ſtomach are *not diſcharged* of their powers, that *accumulation* of powers excites, or is the cauſe

of there being excited, in the nerves, the *ſenſation of hunger*, or the *deſire* for *food*.

16. The *nerves* of the ſtomach, then, are *involuntary* in their actions, but ſtill capable of communicating and exciting the *ſenſation* of *hunger* in the brain; they, therefore, have ſome *peculiarity* which diſtinguiſhes them from the involuntary nerves of the heart and blood veſſels, in common;—from whence then are they derived?—in what does that difference conſiſt?

17. The nerves of the heart and vaſcular extremities are chiefly ſupplied from the intercoſtals, and ariſe from *ganglia*, which *cut off* immediate communication with the brain; but, the nerves of the *ſtomach* are chiefly derived from the *par vagum*, which have *no intercepting ganglia.*

18. Both the nerves of the intercoſtals and par vagum, are *expanded* upon the *ſurfaces* of the *veſſels*, and then terminate in the *muſcular fibres*, which renders them *only* excitable by the application of *ſtimuli* to thoſe *expanſions*; but,

when a ſtimulus is applied to the expanſions of the *par vagum*, *that* excitement may be communicated to the brain itſelf, as there are *no* interrupting ganglia.

19. That this is in reality the caſe, is rendered obvious by many conſiderations, and none is more convincing than the inſtantaneous excitement which is communicated to the brain and the whole ſyſtem, when exhauſted by fatigue, by the taking *wine* or *ſpirits* into the *ſtomach*. The *phlogiſtic power* in thoſe liquids inſtantly excites the *nerves* of the ſtomach to *diſcharge* themſelves in actuating the *muſcular fibres*; and the excitement of the *nerve* is inſtantly communicated to the *brain*, and to *every nerve* in the ſyſtem, with which the par vagum are connected.

20. When the formation of the par vagum was under conſideration, in the ſection on reſpiration, it was concluded, that the *par vagum* were formed of *branches*, *ſent off* from *all* the nerves of motion, derived immediately from the brain; conſequently, though the par vagum

do not immediately ariſe from the centre of volition in the brain, ſtill, they are ſimply *connected* with *all* the *nervous origins* in the brain; and, as the nerves have a peculiar *vitality* or *animation*, which rapidly conveys impreſſions when thoſe nerves are free from interruption, it is evident, that when the nerves of the ſtomach are excited to a ſufficient degree to conſtitute ſenſation, *that excitement* will be inſtantly communicated to *all* the *nerves* from which they ariſe, and from them to the *brain*; ſo that the *ſtate* of the nerves of the ſtomach is inſtantly *communinicated* to *all* the *nerves* of *motion*, and to the *brain itſelf.*

21. This ſtatement is corroborated by many other facts; for we know that certain ſtates of the ſtomach do affect even the voluntary muſcles, in ſuch manner as to render them active, in oppoſition to the will, as in ſpaſms and convulſions, which ariſe from the *nerves* of the *ſtomach* being irritated and excited, and from that irritation and excitement being communicated to the *nerves* of *volition* from which they ariſe.

22. The branches of the par vagum which are diſtributed to the *ſtomach*, are not the *only nerves* which communicate their vital or animated excitement to the brain, becauſe, the inteſtines themſelves,- are capable alſo of communicating certain ſenſations when ſtrongly excited; and thoſe branches which paſs to the *lungs*, have the ſame power, as is evident from the coughing excited by irritating the lungs; from the ſenſation of oppreſſion when pure air is withheld; from the pleaſing relief which the admiſſion of pure air to the lungs affords; and from the excitement which the pure air communicates to the brain by the connecting nerves in certain caſes of ſuſpended animation; for, when the functions of the brain, and the actions of the lungs have ceaſed, the excitement which pure air gives to the nerves of the lungs, is communicated by the vital powers of the nerves to the brain, and its functions are revived; the powers put in motion; the muſcles of reſpiration thrown into action; the nerves of the lungs diſcharged, and life reſtored.

23. The ſtomach, then, receives its nerves, *chiefly*, from the par vagum ; and when the powers flowing conſtantly into thoſe nerves from the brain, are not *duly diſcharged* for *want* of the *phlogiſtic power* in the *blood*, thoſe powers *accumulate* and flow, more particularly, into the *nerves* which are diſtributed to the mouth, the tongue, the ſalival glands and muſcles of deglutition, by a peculiar communication, ſimilar to what takes place between the branches of the par vagum ſent to the lungs, and the nerves diſtributed to the muſcles of inſpiration; as is evident from the degree of tenſion, of action, of excitement, of deſire for food, and from the copious ſecretion of ſaliva which accompanies that deſire and the ideas which it excites.

24. It is very evident that the blood in the ſtomach and inteſtines, and their glands, and in their large appendages of the liver, pancreas, &c. muſt require a *great degree* of *muſcular action* in the *veſſels themſelves* to circulate it: that muſcular power muſt be derived from the nerves; thoſe nerves muſt be excited by the blood; and

that blood, to be capable of exciting them, muſt poſſeſs *both* the *æthereal* and *phlogiſtic powers*, in certain proportions, otherwiſe the powers muſt *accumulate* in the nerves, and the circulation muſt become *ſlow* and *difficult,* for want of muſcular action. Whenever, therefore, the æthereal power is wanting, nature hath wiſely contrived that the powers, not being diſcharged from the *nerves* of the *lungs* for want of æthereal air, muſt *regurgitate* to the *nerves* and *muſcles* of *inſpiration*, by which means pure æthereal air is brought to the blood: and whenever the *phlogiſtic power* is wanting, it is ſo contrived, that the *powers, not* being *diſcharged* from the nerves of the ſtomach for want of phlogiſtic power, muſt *partly regurgitate* into the nerves ſupplying the tongue, mouth, fauces, and their peculiar glands, accompanied with the *ſenſe of hunger.*

25. As the lungs and ſtomach are peculiarly deſtined to ſupply the ſyſtem with the air and food, without *both* which life *cannot long* be ſupported, it is neceſſary their actions ſhould be regulated by the *wants* of the ſyſtem, or its *ex-*

penditures; and that, in caſes of danger, the intellectual power itſelf ſhould be alarmed, and the aſſiſtance of reaſon called in; for which purpoſes, the par vagum are connected with *all* the nerves ariſing from the brain, and receive a flow of the æthereal and phlogiſtic powers, *proportionate*, at all times, to the flow to the *reſt* of the *ſyſtem*; and the intercourſe between the brain and extremities, or expanſions of the par vagum, is *not* interrupted by *ganglia*, as is the caſe with the intercoſtal nerves; in conſequence of which, powerful irritations or excitements of thoſe *nervous expanſions*, are communicated to the *brain*; more particularly ſo when the powers are accumulated there, while the functions of the brain are unimpaired; and, likewiſe, by this *free* courſe of the par vagum, when ſudden exertions or mental emotions excite a rapid flow of powers by the nerves, a ſudden flow muſt, *alſo*, paſs to the lungs, ſtomach, heart, inteſtines, and every part to which the par vagum are diſtributed; in conſequence of which, the *uſual ſtimuli* will inſtantly produce a *greater action*, and at *ſhorter intervals*, till the increaſed flow is *exhauſted*.

26. But, the ſimple vaſcular actions propelling the blood in a circuitous courſe, is not all which requires conſideration, reſpecting the ſtomach. The *glandular actions* and *ſecretions*, and the conjoint effects of the blood, the aliment, and the nerves, require attention. They, indeed, require more attention than is compatible with my preſent plan; and I ſhall, therefore, only conſider them in a general point of view.

27. The *glands* of the *ſtomach* are formed of arteries and veins, conveying blood, and of nerves giving motion to the muſcular fibres in their texture. But, in theſe glands, the *blood itſelf* is *decompoſed*, which can only be effected by the *æthereal* and *phlogiſtic powers* flowing off from the extremities of their reſpective *nervous fibrillæ*, in a ſtate of *ſimple expoſure* to the blood, or other fluids having acceſs to them, *without* being *connected* with *muſcular fibres*.

28. In this ſtate of *ſimple termination*, the nerves are readily *excitable* by the blood or fluids acting on their extremities, and, as readily com-

municate *that excitement* to the *brain*;—and, as both the *æthereal* and *phlogiſtic nerves* are *ſimply expoſed*, it is evident, that the *degree* of excitement imparted to *either*, will *vary* as the *qualities* of the exciting *fluids* vary; and, conſequently, that *either* of them may be *particularly excited*, while the *other* is *leſs* excited than uſual.

29. It muſt likewiſe follow, that when the *æthereal* nerve is *more* excited than the phlogiſtic, the *flow* of the *æthereal power* from *that* nerve, into the *blood* or exciting fluid, will be *greater* than the flow of the phlogiſtic power; and, conſequently, that the *change* produced in *thoſe fluids* will be *different*, from what is effected when their excitements are equal, and *vice verſa*; and, it muſt likewiſe follow, that the *ſenſations* excited and communicated to the brain, *muſt vary*, as the *relative excitements* of the two powers become *different* in degree.

30. The nerve which conveys the æthereal power, has a vital principle, which, when excited, imparts *motion* to that æthereal power;

conſequently, it is natural to ſuppoſe, that the æthereal power *in motion* will excite the *vital principle* of that nerve; the vital principle and æthereal power being mutually ſubject to each other's influence. For the ſame reaſon, the *animating* principle of the nerve which conveys the phlogiſtic power, muſt be excitable by the *phlogiſtic power* in *motion* in the *blood*.

31. But although the *phlogiſtic power* in the *blood*, is capable of exciting the *animating principle* of the nerves which naturally *convey phlogiſton*, it is not capable of receiving and *combining* with that phlogiſtic power of the nerves; it merely *excites* the *animating* principle of the nerve, which excitement is communicated to the brain; but, the phlogiſtic power of that nerve cannot be *diſcharged*, unleſs the contrary *power*, or the antacid *principle*, be preſent to receive it. By that excitement, however, the power of the nerve is ready to *act* with *energy*; and if the *contrary power* be preſent to receive it, it will *flow* from the nervous extremity and *combine* with that contrary power in the exciting fluid: but, if

the contrary power be *not* there in *ſufficient quantity* to ſaturate it, it will be excited to *arrange* itſelf around the *antacid principle* in the *blood*, or to enter into ſuch a ſtate of *combination* as the circumſtances will allow. In the ſame manner, the *vital* principle of the *æthereal* nerve may be excited by the *æthereal* power in the *blood*; in which caſe, the *æthereal powers* will flow from the nervous extremity, and *combine* with the *phlogiſtic* power if preſent in the blood in ſufficient quantity; or, it will combine with the *acid principle* in the ſtate of *arrangement*, or ſuch a ſtate as the circumſtances will admit of.

32. We know that when the blood is fully ſupplied with the phlogiſtic powers, and the actions of the ſtomach, &c. are duly excited, the deſire for food is not perceived; but, when the *phlogiſtic* power is conſiderably *expended*, the appetite returns, and increaſes, in proportion as the phlogiſtic powers become *deficient*: the *powers* ſent to the nerves of the ſtomach and *not diſcharged*, then, *excite* the *ſenſation* of *hunger*:—but the nerves of involuntary motion in the

heart and vaſcular extremities of *other* parts, are *not excited* to *ſenſation* by the *accumulation* of their powers; therefore, it is reaſonable, from analogy, to ſuppoſe, that it is not the *accumulation* of powers in the nerves which are diſtributed to the *muſcular fibres* of the arterial and venous extremities, which immediately communicates to the brain the excitement of *deſire* for *food*, but, that it is the *powers accumulated* in *thoſe nerves*, which, without *any* connexion with muſcular fibres, *ſimply terminate* in the *glands* of the *ſtomach*, and are expoſed to the *influence* of the *blood*, and of the *fluids* ſeparated *from it*, *which* excite the ſenſation of hunger or deſire for food: and, as the appetite increaſes as the phlogiſtic power becomes deficient, to a certain degree, and as the nerves of involuntary action in the ſtomach become *ſurchaged* with powers, for *want* of phlogiſtic excitement, it is probable, that the *powers* accumulating in the *nerves* of *motion* of the ſtomach, *communicate* with, and *diſcharge* themſelves, in *part*, by the *nerves* thus ſimply terminating in the *glands* and *inner ſurface* of the ſtomach. If the phlogiſtic power be exhauſted to a great degree, the functions of the brain and nerves will be impaired, and the powers of the ſtomach, of courſe; in conſequence of which, the ſecretions will be *imperfect*, and the power of *digeſtion* confined to a ſmall extent; but at preſent I am only conſidering the conſequences of *temporary abſtinence*, which does not proceed ſo far as to produce any material change in the œconomy of the brain and nervous ſyſtem, in general.

33. If, then, a man, in health, be kept from food, but duly ſupplied with air, at firſt, he will find no inconvenience. The blood circulating to the brain, excites it to tranſmit a regular flow of the æthereal and phlogiſtic powers to all the nerves; thoſe nerves communicate a portion of thoſe powers to the par vagum; and part of the nerves which conſtitute the par vagum paſs to the ſtomach. The nerves which are thus diſtributed to the ſtomach have *two* modes of *termination*; *one portion* of them are expanded on the *extremities* of the *blood veſſels*, and, being excited by the *blood*, communicate their powers by ner-

vous fibrillæ to the *muſcular fibres* of thoſe veſſels, and excite them to act; the *other portion* of thoſe nerves, *terminate*, ſimply, in the *glands*, where their extremities are expoſed to the *chemical action* of the *blood.*

34. While the blood, then, *abounds* with the *phlogiſtic* power, the powers flowing to the ſtomach are duly diſcharged, and the blood is freely circulated.—But, when phlogiſton begins to be conſiderably *expended* and *deficient*, the nerves of the *vaſcular* extremities are not ſufficiently excited to *diſcharge* themſelves: ſo long as the functions of the brain are duly ſupported, and its powers abound, the flow of powers to the nerves of the ſtomach muſt continue, ſo long as thoſe powers flow to any other part; they muſt, therefore, *accumulate* in the nerves ſupplying the muſcular fibres of the ſtomach; and the flow of the powers will, then, be *chiefly diverted* to the *nerves* which *terminate* in the *glands.*

35. Theſe nerves, ſimply terminating in the *glands* of the ſtomach, and having no *ganglia* in-

terrupting them, in their courſe from the brain to the glands, by this *increaſe* of powers will become *more ſenſible*, and likewiſe more capable of *decompoſing* or *changing* the *blood*, by being excited to *diſcharge* their reſpective powers *into it*: they will, therefore, be more *excitable*, and will diſcharge thoſe powers into the blood, in *greater quantities*; in conſequence of which, a *greater* proportion of the *blood* will be *changed* in its properties; and thoſe newly-acquired properties will alſo be more evident and efficacious, as the powers upon which they depend are more copious; to a certain extent.

36. In this ſtate, the *glandular nerves* of the ſtomach will communicate their *peculiar excitement* to the brain, where it will be perceived in the ſenſation of *hunger*, or the *deſire* for *food*; ſo that the flow of the æthereal and phlogiſtic powers from the nerves of involuntary motion in the ſtomach, being *prevented*, for *want* of *phlogiſtic power*, by this contrivance is made to *ſecrete* a *peculiar fluid* from the blood, which is capable of *diſſolving* thoſe ſubſtances, proper for food,

when taken into the ſtomach; and at the ſame time, the ſenſation of hunger is excited, by which man is powerfully urged to procure ſuch food as is calculated to gratify that deſire, and to reſtore to the ſyſtem *that phlogiſtic power*, which alone is capable of removing the preſent ſtate of excitement of the nerves of the ſtomach and of the brain, induced by the *want* of it.

37. It would carry me beyond my preſent purpoſe, to enter into a minute diſcuſſion of the chemical effects produced upon the blood and elementary ſubſtances in the ſtomach and inteſtines, and to inveſtigate the chemical properties of the fluids ſecreted by the liver, ſpleen, pancreas, &c. I ſhall, therefore, only juſt obſerve, that as the ſecretions of the glands of the ſtomach are particularly excited to activity, by the *want* of *phlogiſtic power* in the blood, the *æthereal power* muſt, when the phlogiſtic power is conſiderably exhauſted, be *moſt copious*; and the *æthereal nerves* of the glands will be *moſt excited :* but, as there is *not* any ſuperabundance of looſely combined *phlogiſton* in the *blood*, the *æthereal power* excited

to flow from thoſe glandular nerves, will be *attracted* to *arrangement* by the *acid principle* in the blood, which will, therefore, acquire a *large proportion* of the *æthereal power*; and, in this ſtate, it will *paſs* into the *ſtomach*, *ſlightly* connected with the antacid principle with its *diminiſhed* proportion of phlogiſton: this *gaſtric fluid*, thus formed, will, when phlogiſtic aliment is taken into the ſtomach, immediately act upon it: the *acid principle* with its *abundant æthereal* power, will attract the *antacid* principle of the *aliment*, and combine with it, and with a *portion* of its phlogiſton; while the *ſuperabundant phlogiſton* which all nutrimental ſubſtances contain, will be *attracted* to *arrangement* by the *antacid* principle of the *gaſtric fluid*, with its *ſmall* proportion of *phlogiſton*; by which means, that *antacid* principle will become again *highly phlogiſticated*; and, mixing with the reſt, will form a *neutral compound*, containing a *large* proportion of *phlogiſtic* power in a ſtate of looſe combination, fit to be received into the blood, and to reſtore to it its eſſential properties.

38. When the blood is *deficient* to a *conſiderable* degree in the phlogiſticated principle, and the *acid* principle abounds, the nerves of the glands ſecrete from the blood, the *acid* principle with the *æthereal* power in *ſuch* proportions and ſtates of combination as to conſtitute an *actual acid*, as is evident in certain caſes of dyſpepſia, and diabetes; and, on the contrary, when *phlogiſton greatly abounds*, as after taking large doſes of opium or ſpirituous liquors, or when the *acid* principle is *deficient*, as in the ſcurvy, the nerves and ſecretions of the ſtomach, are in ſuch ſtates as to be capable of combining with and ſaturating *large quantities* of the *acid principle.*

39. The blood, thus deprived of a conſiderable part of its acid principle in the glands of the *ſtomach* and *bowels*, will *retain* an *unuſual* proportion of the *antacid* principle, and in that ſtate it will be conveyed by the vena portarum to the *liver*; there being expoſed to the nervous extremities, in the glands of that viſcus, it will of courſe, excite the *phlogiſtic nerves* of thoſe glands in particular; they will impart a flow of the phlogiſtic

power, which will render the *redundant* particles of the *antacid* principle *highly phlogiſtic* ; in which ſtate they will paſs off by the biliary ducts, combined, however, with a certain *ſmall* proportion of the *acid particles* ſtill remaining in the blood, in which ſtate they will form the *bile*, a fluid replete with the phlogiſticated principle, which being conveyed into the duodænum, will mix with the alimentary compound flowing from the ſtomach ; when part of that bile will paſs along with the compound chyle into the blood, and part will remain combined with the uſeleſs or ſuperfluous parts of the aliment, whoſe expulſion it will aſſiſt, by its phlogiſtic excitement co-acting with the æthereal excitement of the blood, to *excite* the *nerves* of the inteſtinal canal, to keep up the regular actions of the *muſcular fibres* of thoſe parts.

40. When aliment containing a large portion of the phlogiſtic power is, then, received into the ſtomach, thus excited and thus ſupplied with the fluid ſecreted by the gaſtric glands in conſequence of a deficiency of phlogiſton in the

blood, various effects are produced:—the aliment is attacked by the *two contrary* principles of the gaſtric fluid: the *acid* principle with its *æthereal* power attracts the *antacid* principle of the *aliment*, while the antacid principle of the *gaſtric ſolvent* attacks the *ſuperabundant phlogiſton* of that aliment to which it has a ſtrong attraction of *arrangement* in its preſent *impoveriſhed* ſtate: by this double attack the alimentary matters are *decompoſed*, and the *phlogiſticated principle* is ſubjected to the attractive actions of the lacteals. When the *phlogiſtic* power of the *aliment* is thus *evolved*, it acts alſo upon the nerves of the ſtomach; its *phlogiſtic* principle with the *æthereal* power of the *blood* in the vaſcular extremities, excite the *involuntary nerves* of thoſe parts to impart *motion* to the *muſcular fibres*, by which thoſe nerves become *diſcharged* of their powers, and the blood is *propelled* with freedom; and at the ſame time, this *phlogiſtic* power, now *abundant*, excites the *animating* principle of the phlogiſtic nerves of the glands, which being communicated to the *brain* excites it to perform all its functions with *renewed energy*; while the quickened circulation affords it more copious ſupplies of blood, from which it derives all its powers : and it is highly probable, that the *blood itſelf*, which circulates through the veſſels of the ſtomach and inteſtines, does actually acquire a copious ſupply of the phlogiſtic power, when expoſed to the influence of that fluid or power diſengaged by the gaſtric ſolvent from the alimentary matters taken into the ſtomach, a conſiderable portion of which it retains, when tranſmitted from the liver to the heart, to be tranſmitted through the lungs to the brain and the reſt of the ſyſtem, upon the ſame principles as it attracts the æthereal power from the air, in paſſing through the lungs.

But not to enter more minutely into a ſubject of ſuch wide extent, at preſent, I ſhall cloſe this ſection by drawing the following general concluſions :

1ſt. That the ſtomach is ſupplied with nerves, chiefly from the par vagum.

2d. That thoſe nerves ariſe from all the nerves of motion proceeding from the brain;—conſequently,

3d. That the flow of the æthereal and phlogiſtic powers to the ſtomach, is, at all times, proportionate to the flow to the other nerves; and, therefore, to the degree of action in the ſyſtem.

4th. That the nerves of the ſtomach are partly diſtributed to the vaſcular extremities, where being excited by the powers in the blood or other fluids, they produce thoſe muſcular actions by which the blood is duly circulated.

5th. That other branches of thoſe nerves are diſtributed to the *glands* of the *ſtomach*, in which they *ſimply terminate*; being expoſed to the influence of the blood or fluids in the ſtomach, without any immediate connexion with muſcular fibres.

6th. That when the *phlogiſtic* power becomes *deficient* in the *blood*, the nerves of motion are *not* duly *diſcharged*, for want of the phlogiſtic excitement; and the blood, of courſe, is circulated with difficulty.

7th. That in conſequence of this want of excitement, the powers *accumulate* in the nerves of motion, and flow, in an increaſed proportion, to the nerves diſtributed to the *gaſtric glands.*

8th. That the nerves of the glands, thus copiouſly ſupplied with the æthereal and phlogiſtic powers, are *ſtrongly excited* by the blood in thoſe glands.

9th. That that excitement is communicated to the brain, by thoſe nerves being free from the interruption of ganglia; and there it produces the *ſenſation* of *hunger*, or the deſire for food.

10th. That the nerves of the glands thus excited and abounding in the two powers, *diſcharge* thoſe *powers* in an *excited ſtate* into the *blood*, with which they combine in various proportions, and produce *chemical changes*, from which ariſes a *fluid ſecretion*, which paſſes into the ſtomach, and is called the *gaſtric fluid.*

11th. That this fluid has the property of *diſengaging* the *phlogiſticated principle* of the *aliment* taken into the ſtomach, and of combining with it, ſo as to form *chyle*, or a compound in which the *phlogiſticated principle* forms a *conſiderable part*, and is *ſo evolved* as to be capable of exerting its ſpecific powers, and when received into the blood, of *reſtoring* to it its *phlogiſtic* properties, and power of *exciting* the *muſcular* actions of the ſyſtem.

12th. That the *phlogiſtic* power thus evolved in the ſyſtem, immediately, with the co-operation of the æthereal power in the blood, excites the *vaſcular actions* of the ſtomach, &c. and diſcharges thoſe nerves of motion of their accumulated powers; by which the blood is again circulated with freedom to the heart.

13th. That, at the ſame time, it excites the *animating power* of the phlogiſtic nerves; which excitement being communicated to the brain, is again tranſmitted to *every part* of the ſyſtem; in conſequence of which, all the functions of the brain and nerves are performed with *increaſed energy*.

14th. That, at the ſame time, that the animating principle of the brain and nerves is excited by the phlogiſtic power in the ſtomach, the *motion* of the *blood* is *accelerated*, and furniſhes powers in proportion to the excitement of the animating principle.

15th. That the nerves of the ſtomach have a peculiar communication with the nerves diſtributed to the tongue, ſalivary glands and muſcles of maſtication and deglutition; in conſequence of which, when the nerves of the ſtomach are peculiarly excited by the accumulation of powers, a portion of thoſe powers is tranſmitted to the nerves of the mouth, fauces, ſalivary glands, &c. by which they are peculiarly excited alſo and ready to aſſiſt in preparing food for the ſtomach.

16th. That by theſe means the *appetite* for food containing the phlogiſtic power, and the *power* of *digeſting* it, is proportioned to the *expenditure* of that peculiar power by the muſcular actions of the ſyſtem; the *defect* of phlogiſtic power in the ſyſtem producing ſuch an *accumulation* of powers in the nerves of the ſtomach, as *excites* the *deſire* for phlogiſtic food, which can only be *ſatisfied* with the application of proper *nutriment* to the ſtomach, already provided with a ſolvent capable of rendering that food fit to reſtore to the blood *that phlogiſtic power* it is in want of.

Having thus taken a general view of the natural functions of the ſtomach, the lungs, the brain and nerves, the heart and ſanguiferous veſſels, and of the muſcular fibres, and the manner in which thoſe functions are excited and exerted, I ſhall not enter upon any more minute conſideration at preſent:—theſe are the moſt important parts of the ſyſtem, and to enter upon the operations of leſs conſequence would extend this tract beyond the bounds I intended.

The blood, however, is of too great importance to be overlooked; I ſhall, therefore, devote the next ſection to a few obſervations upon it.

SECTION XIII.

On the blood.

1. THE blood is the grand circulating medium, from which all the powers of the ſyſtem are derived; by the aſſiſtance of which moſt of its operations are performed, and by whoſe motion and active qualities many of the actions of the ſyſtem are excited.

2. The blood, naturally, contains a *large* proportion of *phlogiſtic power* attached to its antacid principle; but to give it a due degree of firmneſs or conſiſtency, and to enable its antacid principle to retain the phlogiſtic power in great proportions, a certain quantity, or proportion, of the acid principle with its æthereal power in a minor proportion, are neceſſary.

3. That the blood does contain a large exceſs of phlogiſtic power in a natural healthy ſtate, is evident from what has already been obſerved, (ſect. xii. par. 5.) that a man in health conſumes twelve or fourteen hogſheads of atmoſpheric air in a day; conſequently, as a man may live ſeveral days without food, and as the air is conſumed nearly in the ſame manner as by combuſtion, it is evident, that the blood muſt contain as much phlogiſtic power, in a man in good health, as would decompoſe nearly, or perhaps entirely, one hundred hogſheads of common atmoſpheric air, by combining with the æthereal acid of the air, and converting it into fire, and partly into fixed air.

4. From this conſideration, it is evident, then, that in common life and health the blood *does contain* a *large exceſs* of *phlogiſtic power*, in conſequence of which it is capable of ſupporting the functions of life for a conſiderable time, *without freſh ſupplies*; but that time is limited, and food muſt again be ſupplied, or death will enſue.

5. The blood, however, requires conſtant ſupplies of the æthereal acid, from the lungs, as well as of the phlogiſticated principle from the ſtomach, as is evident from the fatal effects ſo quickly ariſing upon the excluſion of air from the lungs; the æthereal air being as neceſſary in the blood to ſupport the functions of life, as it is to ſupport the burning of a taper.

6. The blood being a compound in which the phlogiſticated principle abounds, will, naturally, attract the æthereal acid of the atmoſpheric air in the lungs, as it evidently does; acquiring a more florid colour and more exciting powers than it naturally poſſeſſes when without the æthereal acid.

7. But when the antacid principle in the blood attracts the acid principle of the air, it *loſes* its power of *retaining* ſo *great* a proportion of *phlogiſton*: thoſe particles of the blood, therefore, which have the opportunity of attracting the æthereal acid, will *give out* a portion of *phlogiſton*, which, being attracted by the *antacid*

particles in the *air*, or by the adjoining particles in the blood if the former be abſent, thoſe antacid particles will, alſo, *combine* with a *portion* of the *æthereal air*, which will be partly *decompoſed* and conſtitute *water*, or *fixed* air, according to the circumſtances of the antacid principle, to which the phlogiſton of the blood was tranſferred, when the æthereal acid was received into it.

By the *antacid* principle in the air and in the blood, I mean that principle which by the modern anti-phlogiſtians is called azote, as well as that of hydrogen.—Azote, hydrogen, and carbon, are, to a certainty, the *ſame principle*, only in *different ſtates*, with reſpect to the *phlogiſtic power* arranged with them—which differences may perhaps depend upon certain portions of the acid principle in intimate combination.—The *antacid* or *alkaline principle*, therefore, I employ as a *general term*, which implies the *ſame principle*, whether it be in the ſtate of earth, alkali, carbon, azote, or hydrogen—thoſe minuter diſtinctions may be uſeful in chemiſtry, but in my preſent ſubject are unneceſſary.

8. Venous blood will attract the pure air from the phlogiſticated air in the common atmoſphere.

Phlogiſticated air will attract the pure air again from that blood :—but what phlogiſticated air ? — Not the phlogiſticated air left when blood attracted the pure air from it, but the phlogiſticated air produced by combuſtion.

The phlogiſticated air, then, produced by *combuſtion* is *different* from *that* left when venous blood is expoſed to common air, becauſe, it *will* attract the æthereal acid from arterial blood, which the other *will not* ; otherwiſe, ſo ſoon as the blood had attracted the pure air from common air, the phlogiſticated air left would attract it again ; which it does not.

How then does it differ ?—In being deprived of the æthereal acid by the *violent action* of *heat*, and in having *attracted* into *arrangement* a *large proportion* of the *phlogiſtic power*; according to the third general law, (ſect. vi.) that *every* chemical *principle* in proportion as it becomes *deprived* of the contrary *principle* in *combination*, acquires *that power* to which it has an *affinity*, which it excites to *arrangement*.

The phlogiſticated air, then, procured by combuſtion, by means of its *exceſs* of *phlogiſton*, will decompoſe the florid blood; it will readily impart a *portion* of that exceſs of *phlogiſtic power* to the blood, and by that means will *recover* its *attraction* to the *æthereal acid* in the blood; which æthereal acid will be *leſs forcibly* held in combination by the blood, in proportion as the *ſlightly* excited *phlogiſton* of the *air attaches* itſelf to the *antacid* particles of the *blood*, containing a *leſs* proportion of phlogiſtic power than the air does, and, conſequently, more attractive to it.

11. The blood, then, when expoſed to the influence of the air in the lungs, acquires the *æthereal acid*, and becomes *replete* with *both*

the *æthereal* and *phlogiſtic* powers; in which ſtate it is circulated to every part of the ſyſtem. It excites the functions of the brain by its powers and motion; it imparts thoſe æthereal and phlogiſtic powers to the brain and nerves; it excites the involuntary nerves expanded upon the ſurfaces of the veſſels in which it circulates; its powers are again excited by thoſe nervous powers flowing to the material particles in muſcular arrangement, by which means, thoſe particles are attracted towards each other, and conſtitute muſcular contraction; and by the diſcharge of the nervous powers along the muſcular fibres, its powers are made to combine and form fire, which diffuſing itſelf in the blood preſent, conſtitutes the heat of animal life, which is always of courſe proportionate to the degree of muſcular action in the ſyſtem.

12. That the æthereal and phlogiſtic powers of the blood are thus diſpoſed of, is evident from many conſiderations: both are equally neceſſary to ſupport the functions of the ſyſtem: both are equally required in proportion to the actions

of the ſyſtem: the blood is equally deprived of them, by paſſing to the brain, to ſupply it and the nerves with powers, as it is in paſſing to the muſcles to aſſiſt in their actions; and both diſappear in conſequence of the diſcharge of the nervous powers along the muſcular fibres, in the ſame manner as they do when they are expoſed to the excitement of the ſame powers in electric ſtates being diſcharged through the blood, which, from florid, is inſtantly changed to black; the æthereal power being expanded and excited by the electric exploſion, to combine with the phlogiſtic power, and form heat.

13. The blood is liable to conſiderable changes from various circumſtances; the *proportion* of the *two material principles* may be conſiderably *varied*, in conſequence of which its conſiſtency and properties will be changed; but as theſe conſiderations are more ſtrictly pathological than phyſiological, I ſhall not at preſent enter into them.

14. The blood, alſo, in the healthy ſtate, is

liable to a variety of changes, in conſequence of its *expoſure* to the immediate *influence* of the *nerves* and the *powers* which they impart to it, producing *various* fluids, with *different* properties, in the *different glands* where thoſe new compounds are formed, and ſecreted from the general maſs.

15. The glands differ from each other with reſpect to the ſtate in which the nerves are expoſed to the blood; the proportion of powers which they convey with reſpect to the quantity of blood in the gland; and with reſpect to the proportion which the æthereal and phlogiſtic nerves, diſtributed to different glands, bear to each other.

16. The ſecretions of the ſame gland may *vary* at different times, and in different circumſtances, on account of the *different ſtates* of the *blood*, with reſpect to its material principles and its powers, and their relative proportions; on account of the different proportions of the æthereal and phlogiſtic powers in the *brain* and

nerves; and on account of the degree of *ſtimulus* applied to the extremities of the glandular nerves themſelves; to take no notice of the various cauſes which may ariſe from morbid ſtates of the glands, or of contiguous, or connected parts.

17. That the æthereal and phlogiſtic powers may exiſt in the brain and nerves in *different proportions,* is very evident, from obſerving the effects of a large doſe of *opium,* which is of a highly phlogiſtic nature; it excites the *animating principle* of the *phlogiſtic nerves,* and, at the ſame time, it *diminiſhes* the *excitement* of the vital *æthereal nerves*:—it *fills* the brain, the nerves, and even the blood, with its *phlogiſtic* power, and it exhauſts the nerves, the brain, and blood, of their *æthereal* power, in a *great degree,* by *combining* with it: it *diffuſes* itſelf by the phlogiſtic nerves to every part of the ſyſtem: it requires *large* ſupplies of *pure air* to diſcharge it from the nerves, by exciting their reſpective actions: the *ſecretions* of the glands become *changed* by the *exceſs* of *phlogiſtic power* flowing

off from the phlogiſtic nerves of the *glands*; nay, even the diſcharges from *ulcers*, which were before the taking of the opium, *thin* and *acrimonious*, are rendered *mild*, *thick*, and *purulent*.

18. With reſpect to the blood, we may then draw the following general concluſions:

1ſt. That it conſiſts of the antacid principle, with a large proportion of phlogiſtic power; rendered ſufficiently firm and conſiſtent by the intervening attraction of a ſmall proportion of the acid principle.

2d. That the blood thus compoſed *chiefly* of the *phlogiſticated principle*, has a power of attracting the æthereal air, when expoſed to its influence in the lungs; which æthereal acid it will attract into a ſlight degree of combination; by which it will, however, loſe a *part* of its power of attraction to the *phlogiſtic power*, which will, therefore, be *transferred* to *one portion* of the *air*, while the other portion of that air is taken into the blood.

3d. That the blood thus abounding in the phlogiſtic and æthereal powers is conveyed to every part of the ſyſtem. To the brain and nerves it imparts its powers: the vital and animating principles of the involuntary nerves it excites to give motion to the heart, lungs, ſtomach, bowels, and, in ſhort, to all the arterial and venous extremities in the body; and the actions of the voluntary muſcles themſelves, it ſupports, by means of its powers, which the nerves of thoſe muſcles excite to form the attractive *media*, which draw the particles of matter in muſcular arrangement towards each other.

4th. That the blood immediately acts upon the ſimple extremities of the æthereal and phlogiſtic nerves, ſingly, terminating in the glands of different kinds; and, conſequently,

5th. That as the proportion between the æthereal and phlogiſtic powers in the blood varies, the excitement which the blood gives to the glandular nerves muſt vary alſo; and, therefore, 6th. That as the proportions between the æthereal and phlogiſtic powers in the blood, or in the nerves ſupplied from the blood, or in both, differ, at different times, and in different circumſtances, ſo muſt the ſecretions effected by thoſe glands differ in conſiſtency, activity, and in their qualities or chemical properties.

To enter more fully upon the ſubject of glandular ſecretions is, at this time, not neceſſary; neither ſhall I now ſtop to conſider the abſorbent ſyſtem, any further than juſt to ſay, that the operations of the *abſorbents* are chiefly dependent upon the muſcular fibres in their compoſition, and that their actions are excited in the ſame manner, or upon the ſame principles, as the vaſcular actions in general; that is, by means of the blood contained in their component veſſels and by the fluids they convey, conjointly exciting the involuntary nerves ſupplying thoſe muſcular fibres to throw them into action: in ſhort, the abſorbents in general are actuated by the ſame means as the *exhalents*, and they again are excited to action by the very powers which produce the vaſcular actions of the blood veſſels, with whoſe extremities they are intimately connected, if exhalation is not performed by the extremities themſelves.

SECTION XIV.

On the intellectual operations of the brain; and on the nerves diſtributed to the organs of ſenſation.

1. BY intellectual operations, I mean the various degrees and kinds of excitement of the intellectual powers of the brain, by which it perceives impreſſions upon the nerves of ſenſation, actually exiſting as ſenſations; by which it recollects former impreſſions, as ideas; by which it compares ſenſations or ideas with each other; by which it reaſons and determines; and by which it executes its determinations, by tranſmitting power to the muſcles, whoſe actions are ſubſervient to thoſe volitions.

2. The intellectual powers alone are capable of feeling, reaſoning, and determining; and they alone are conſcious of their exiſtence, and

of the various kinds of excitement communicated to them.

3. The intellectual powers are not conſtantly excited, as is evident in ſleep. They, therefore, do *not* depend upon any *one* ſimple principle or power, in connexion with the brain; becauſe, if they did, ſo long as that connexion exiſted, and the brain remained unchanged, the intellectual operations would *continue* uninterrupted.

4. The intellectual powers, then, only act when they are ſufficiently excited; and they are particularly excited to action by impreſſions made upon the nerves of ſenſation, and communicated by thoſe nerves to the brain.

5. The intellectual operations, then, are excited by ſenſations communicated by the nerves; and when once excited, they proceed in attending to thoſe ſenſations; to the ideas excited by them; and to think, reaſon, and act, as cir-

cumſtances excite, or former experience influences.

6. But all theſe intellectual operations of recollection, reaſoning, and determining, depend upon *prior* impreſſions: no man can reaſon, without comparing ideas; ideas cannot be compared, without recollecting them; and recollection is merely a *revival* of *former impreſſions*;—conſequently, then, *all* the *operations* of the *mind* depend upon *ſimple impreſſions*; and thoſe were imparted originally from the *nerves* of *ſenſation.*

7. *Senſations*, then, are ſimple impreſſions made upon the nerves, diſtributed to the organs of ſenſe, by ſuch ſubſtances as are capable of exciting thoſe nerves, in their peculiar ſtates of organic arrangement and connexion with matter; which ſenſations are communicated to the *common ſenſorium* by thoſe nerves.

8. As all the nerves of ſenſation are derived from the ſame common ſource, and are ſimilar

in ſubſtance, ſtructure, and in the faculty of conveying impreſſions to the ſenſorium commune, and only differ from each other in the manner in which they are diſtributed, and *combined* with *matter* in the different organs to which they are extended, it is reaſonable to ſuppoſe, that the *kind* of *excitement* which is given to them depends upon this *peculiar organic arrangement* and *combination* with *matter*.

9. It is reaſonable, then, to conclude, that the peculiar kinds of excitement of the nerves of ſenſation depend entirely upon the peculiar *ſtates* of thoſe nerves in the *organs of ſenſe*; and that whatever be the kind of excitement given to the powers, or animating principle of the nerves, thus peculiarly connected and arranged with matter, *that excitement* is accompanied with a *peculiar ſenſation*, which is communicated to the *brain*; and, conſequently, as the nerves are *differently* diſtributed and connected with matter in the different organs of ſenſe, they muſt be peculiarly liable to be excited by different kinds of matter; their *excitements* muſt be eſſentially

different; and the ſenſations excited in the brain by impreſſions upon one organ of ſenſe, muſt be eſſentially different from all other ſenſations from other nerves.

10. The *powers*, then, whoſe action conſtitutes *intelligence*, ſeem to be extended along the nerves of ſenſation to the organs of ſenſe themſelves; and the peculiar *excitements* communicated to thoſe intellectual powers, being *variouſly modulated* by the matter organically combined with them, excite *various ſenſations*, which are communicated to the ſenſorium commune; and this peculiar excitement *terminates* at the *origin* of the nerve excited in the ſenſorium commune, where it produces a certain *ſenſation*, or *perception*.

11. When that ſenſation *ceaſes*, by the removal of the exciting cauſe, ſtill the mind or intellectual powers, in action, have the faculty of *reviving* that kind of excitement in the ſenſorium commune, when it forms an *idea*, or *recollection* of a former ſenſation: but this power

of recollection, this idea, this revival of a former ſenſation, depends upon the *preſent* excitement of the intellectual powers having ſome reference to, or connexion with, the nerve which communicated that ſenſation originally: conſequently, it appears probable, that when a peculiar nerve is excited to a *certain kind* of ſenſation, the *animating power* of that nerve has a *tendency* to *repeat*, or *revive* the various degrees of excitement to which it *has been* accuſtomed; which repetition of excitements conſtitutes a revival of *ideas*, or *recollection* of former impreſſions.

12. When the animating principle of a nerve, at its origin in the ſenſorium commune, has been *repeatedly excited* in a certain manner, whenever that nerve is excited to ſenſation, it will have a tendency to aſſume *that peculiar degree*, or *ſtate of excitement*, to which it has been moſt accuſtomed, which will, therefore, preſent the *idea* which *correſponds* to that accuſtomed ſenſation.

13. In ſhort, whenever the intellectual prin-

ciples or powers of the brain are excited, it is by the action of the exciting cauſe *in motion* imparting excitement to the *animating powers* of the *nerves*; which excitement is productive of *motion*; and the excitement and motion, *together*, are communicated to the ſenſorium commune of the brain.—And, as the intellectual powers of the brain are ſometimes *quieſcent*, and only poſſeſs intelligence when *excited* to *action*, it is highly probable, that *excitement* and *motion* in the *nerves* are *ſimultaneous* and *inſeparable*: that when excitement is communicated to the ſenſorium of the brain, motion invariably accompanies it, as being eſſential to excitement; and, conſequently, that the *intellectual powers* of the *brain only exiſt* when in a ſtate of *excitation*; and when excited, that they are in conſtant *action* or *motion*.

14. In fact, it appears evident to any common obſerver, if he will but for a moment ſtop to conſider:—an impreſſion made upon a *diſtant* nervous extremity, may communicate a ſenſation to the *brain*; which may excite *various*

ideas; which again may terminate in *volition*, by which certain muſcles are thrown into *action*.—It is evident, then, in ſuch a caſe, that the impreſſion upon the nerve of ſenſation produces *motion*, as well as *peculiar excitement* in the nervous extremity; *that* active excitement is rapidly conveyed to the *brain*, becauſe the intellectual powers of the brain are *excited* ſo as to *recall* various *preceding* impreſſions in the ſtate of *ideas*, which were communicated by *different* nerves, and, conſequently, to *diſtant* parts of the ſenſorium commune; after this intellectual action, the excitement is imparted to a ſtill *different nerve*, along which it flows with rapid *motion*, till it terminates in *muſcular contraction*.

15. It appears reaſonable, then, to ſuppoſe, as *motion* excites the intellectual powers to action, as that action in the brain may be communicated to this, that, and the other nerve of motion, and as that action may be excited by motion imparted to very different nerves, that the *intellectual powers*, themſelves, when *excited* to action, are alſo excited to *motion*; that the intel-

lectual action in the *ſenſorium commune* is *progreſſive,* from one nerve to another; that *every* nerve both of ſenſe and voluntary action, has its *diſtinct origin* in the ſenſorium commune; and, that the excitement communicated to the intellectual powers by one nerve, may be propagated to *any* nerve, or nerves, ſimultaneouſly, or in ſucceſſion, whether nerves of ſenſation or volition.

16. A ſenſation, then, is a certain excitement communicated to a nerve, which is modified by the ſtate of the nerve itſelf, in the organ of ſenſe, and by the ſtate or qualities of the ſtimulus or exciting cauſe acting on the nerve. Every different organization of the nerve, when expoſed to the action of ſtimuli, will produce a different degree or kind of excitement; and what is capable of exciting one nerve, may not be in the leaſt adapted to excite another, differently expoſed and combined with the principles of the organ, or part.

Whatever be the excitement given to the

nerve, it is communicated to the brain; and every different excitement muſt produce a different ſenſation, or *perceptive motion* of the intellectual powers.

17. An idea is a kind of *revival* of the *perceptive motion* of the intellectual powers, which has formerly been excited by a nerve; and when two or more ſenſations, or ideas, have been frequently excited *together*, or in conſtant *ſucceſſion*, whenever one of thoſe ſenſations or ideas is excited, the other ideas are perceived to ariſe in the mind, in regular order, in conſequence; and if a certain idea or ſenſation has frequently been excited in the brain, and as conſtantly has terminated in the *exertion* of a *certain muſcle*, or *muſcles*, whenever that idea is again excited, the intellectual actions will impart a flow of powers to that *nerve* of *motion*, unleſs other ſenſations, or ideas occur, to prevent it.

18. It appears evident, then, that the intellectual powers are excitable by matter, producing motion in thoſe powers; and that *that* motion may

be propagated to any or every nerve originating in the ſenſorium commune; and from thence to any or every voluntary muſcular fibre in the body.

The powers of other bodies act upon the powers of the nerves of ſenſe; they act upon the intellectual powers; and thoſe again upon the muſcles:—but, the nerves certainly act by means of the *æthereal* and *phlogiſtic powers*; when thoſe powers of the nerves are excited to act on the brain, the intellectual powers are excited; and intellectual excitement ſent to the muſcles is ſtill a flow of the æthereal and phlogiſtic powers.

19. It appears highly probable, then, that the *intellectual* powers of the brain are entirely *dependent* upon the *æthereal* and *phlogiſtic* powers *there*; and that probability is rendered certain by the fact, that the intellectual operations immediately *ceaſe*, if the brain be *deprived* of either the *æthereal* or *phlogiſtic* power, or *both*; as is too well known to need further attention.

20. We know that a ſtrong exertion of the intellectual powers will, if long continued, induce great fatigue, and exhauſt the æthereal and phlogiſtic powers of the brain: we know that in ſuch a ſtate of exhauſtion *ſleep* will reſtore thoſe powers to the brain, if æthereal air and proper nouriſhment are not deficient:—it is evident, then, that the *intellectual* operations themſelves require both the *æthereal* and *phlogiſtic* powers; and that thoſe powers are *conſumed* by intellectual action, but *accumulate* in ſleep.

21. The ſenſorium commune, then, muſt be connected with *thoſe parts* of both the cerebrum and cerebellum, which are particularly formed for the purpoſe of *ſeparating* the æthereal and phlogiſtic powers from the blood:—the *æthereal* power then is conveyed to the ſenſorium commune by *one* ſet of nerves or medullary fibres; the *phlogiſtic* power by *another*.

22. We have, on many occaſions, obſerved, that the powers of a nerve of volition are *qui-*

eſcent, till the *vital* principle is *excited*; and, conſequently, then, it is reaſonable to ſuppoſe, that the powers flowing by their reſpective nervous or medullary conveyances to the ſenſorium commune, may ſtill *remain* and *accumulate* there, if the ſenſorium be *not* excited.

23. *Sleep*, then, ſeems to be that ſtate of the ſenſorium in which there is no *ſufficient excitement*, capable of producing a full *flow* of the æthereal and phlogiſtic *powers* from their diſtinct *ſources*, (21) into the *ſenſorium*. A ſlight excitement may produce a partial flow of the two powers, with imperfect and ill-connected ideas, as we find occaſionally, and which we call *dreaming*, but the *full* exertion of the intellectual powers requires the *free flow* of the æthereal and phlogiſtic powers from their reſpective ſources; by which means, the ſenſorium is *replete* with the *two powers*, and every excitement communicated by the nerves of ſenſation is perceptible.

24. The intellectual principles, then, are peculiarly reſident in the ſenſorium commune:

they are excited to attention and perception by impreſſions on the nerves of ſenſation, being communicated to the ſenſorium: that excitement when in a ſufficient degree is communicated to the animating principles of the *medullary fibres* which *ſupply* the *ſenſorium* with the *æthereal* and *phlogiſtic powers*:—thoſe contrary powers then *flow* to the ſenſorium, in proportion to the *excitement there*; by which means the ſenſorium is not only excited, but it can *act* with *energy*, till that ſupply of powers is *exhauſted*, by the intellectual operations *combining* them *together* in the brain, or *tranſmitting* them to the nerves of *motion*.

25. The intellectual principles, then, *cannot* act without the two powers derived from the blood; and thoſe powers are *quieſcent*, unleſs the *intellectual* principles be *excited* to put them in *motion*.

Intellectual operations, then, are produced by the *conjoint* influence of the *intellectual principles* and the *æthereal* and *phlogiſtic* powers; by thoſe operations the powers are combined and converted into *fire* or *heat*; and by that change of ſtate the ſenſorium becomes gradually *exhauſted* of thoſe powers, in their ſtate of ſeparation, neceſſary to produce intellectual action; in conſequence of which, intellectual excitement naturally *ceaſes*, for *want* of powers; and when the excitement in the ſenſorium ceaſes, the *powers* no longer *flow* into it, but gradually *accumulate* in their reſpective fibres, till they again, by the ſecretions of their reſpective *ſources*, become ſo abundant as to be ready to flow into the ſenſorium, in conſequence of excitement being tranſmitted by the nerves, or of their own accumulation.

26. It is not the brain *alone* which acquires a ſtore of powers by quieſcence, the nerves of ſenſation and voluntary motion alſo, acquire them by ſecretion, or ſeparation from the blood, circulating in their external coverings; in conſequence of which, they alſo become *more excitable* by means of *ſleep*, and impart impreſſions with redoubled energy: thoſe impreſſions or

excitements being tranſmitted to the *ſenſorium,* will be readily conveyed to the *ſources* of its *powers,* and thoſe *powers* will *flow* into the *ſenſorium* in conſequence; by which the *intellectual operations* will become generally *excited,* and all the powers of the mind in readineſs to *act,* as circumſtances may require.

27. When the ſenſorium is thus ſupplied with powers, and the intellectual principles are excited to act with thoſe powers, every peculiar excitement imparted by the nerves of ſenſe is perceptible, with a ſenſation, correſpondent to the ſtate and degree of excitement; and whatever *part* of the ſenſorium is excited, *it* has a natural tendency to *repeat,* or paſs into *thoſe ſtates* of excitement to which it has been *accuſtomed,* if the ſenſorial attention be not excited to a different part; in conſequence of which, *previous* ſenſations may again be revived, under the form of *ideas*:—two or more ſenſations, or ideas, may alſo ſo frequently recur together, or follow one another, that whenever *one* is excited the *other* is revived alſo: and two ſimultaneous ideas may ſo

frequently occur, and ſo conſtantly produce a *third*, that, whenever thoſe two again are revived in the ſenſorium, the *third* is alſo revived as a natural conſequent.

28. In fact, one grand property of the intellectual principles, when excited to action, is, that *previous ſenſations* are *revived* and *perceived* as *ideas*; a ſucceſſion of ſenſations may be revived and perceived as a chain of ideas; two or more perceptions being conſtantly and repeatedly followed by a third, will be revived as cauſe and effect; in ſhort, upon this peculiar property of *repetition* of *ſenſorial actions*, or *revivifications* of *ſenſations* as *ideas*, ſingly, or in aſſociation, *all* the functions of the intellectual powers, which we call mind, depend.

29. It is not my intention to enter minutely upon a ſubject ſo intricate, ſo extenſive, ſo complicated, and important, at preſent; that I ſhall reſerve for my amuſement at a future period, and ſhall only, at this time, make a few obſer-

vations on ſenſations, and then diſmiſs the ſubject.

30. The nerves diſtributed to the organs of ſenſe are formed of the ſame materials as the other nerves; that is, they conſiſt of fibres conveying the *æthereal* and other fibres tranſmitting the *phlogiſtic power*.

31. In the organs of ſenſe theſe diſtinct fibres, I ſuppoſe, are expoſed *together*, ſo as to be *each* and *ſingly*, ſubject to *impreſſions* from ſuch ſubſtances or powers as are capable of acting upon them, through the *material coverings* with which they are always defended.

32. Whatever, then, is capable of acting upon either the æthereal or phlogiſtic nerve, ſo as to *excite* it, is capable of producing a *ſenſation* in the ſenſorium, by the tranſmiſſion of that excitement by the nerve to the brain.

33. If the *æthereal power* of the nerve be

excited, it is natural to ſuppoſe that it will be perceived in the ſenſorium with a *different ſenſation* than if the *phlogiſtic* nerve were excited: and if *both* be excited at the ſame time, the ſenſation perceived in the ſenſorium muſt be ſtill *different* from *either*.

34. But either of the powers we know are capable of *various degrees* of excitement; conſequently, if *either* of them be *ſingly* excited, ſtill the degree or kind of that excitement may be *various*, in different circumſtances; and, conſequently, will excite *various ſenſations* in the ſenſorium, or at leaſt ſenſations *differing* in *degree* or *intenſity*.

35. *Light* is the æthereal and phlogiſtic powers univerſally diffuſed, *excited* in a certain degree, which excitement is *rapidly propagated*: in that ſtate, thoſe powers are of *no colour*, that is, they ſimply excite the ſenſation of *light*, but *not* of *colour*.—If that excitement be propagated through the *atmoſphere* ſurrounding a body, varying in *extent* and *degree* of *excitement*, in conſe-

quence of the form of the body, and if *that* atmoſphere has a peculiar attraction to *one power*, *that* power will be attracted towards the *ſurface* of the body, *particularly*; while the *other* is *not* attracted by the body or its atmoſphere, and would proceed in a right line, were it not *drawn aſide*, *in part*, by the *attracted power*.

The powers conſtituting the light are then *ſeparated*; the æthereal power proceeds in *one* direction, the phlogiſton in *another*; ſtill, however, they are attractive to each other, and form a *coloured ſpectrum*, from which the æthereal and phlogiſtic powers are reflected to the eye, and produce the ſenſations of *various colours* flowing into each other.—The centre of this ſpectrum is *green*, and is evidently formed of the *two powers*, more or leſs perfectly excited and *connected*; while the *medium colour* of *one* end of the ſpectrum is *orange*, and of the *other purple*, or *indigo* as Sir Iſaac Newton termed it.—The warm *orange*, glowing into *ſcarlet*, or attenuated into *yellow*, is ſtill the *ſame power* more or leſs perfectly *excited* and *freed* from the influence of the other power; and the cold *indigo*, or *purple*, deepens into *violet*, or brightens into *blue*, as the principle is more or leſs excited and diſengaged, and is evidently excited by the *contrary power*, to *that* which excites the orange and warm colours.

36. All the ſenſations of *colour*, then, I ſuppoſe, are excited by the *æthereal* and *phlogiſtic powers*, in lucific excitement, being more or leſs perfectly *ſeparated* and *modified* in their *excitements*, by the powers commonly excited and *arranged* around *material bodies*; in which ſtates, paſſing to the expanſions of the *optic nerves*, they excite the æthereal or phlogiſtic fibres of thoſe nerves, or both, in correſpondent degrees; which excitements being tranſmitted to the ſenſorium, are perceived as ſenſations of *colours*, varying with the excitement and the exciting cauſe.

37. In a ſimilar manner, I conceive, all the ſenſations of the different organs of ſenſe, ex-

citable by the *powers* of ſubſtances, are to be explained.

It is not ſimply the atmoſpheric *air* which excites the various modulations of *tone*, which enchant the ſoul with their melodious flow, or harmonious concord, by acting upon the *auditory nerves*, which, like all others, are both æthereal and phlogiſtic,—it is the *æthereal* and *phlogiſtic powers* in general diffuſion around, which are capable of all the *various excitements* with reſpect to *tone*, that they are with reſpect to *colour*. The muſical *ſcale* exactly correſponds with the *ſpectrum* of priſmatic colours:—the three lower tones are excited by one power; the fourth, or middle tone, by the two powers; the three higher by the contrary power to the firſt: the different *velocities* of *vibration* in ſonorific bodies, excite the *one* or the *other power*, or *both*, and excite them *alſo* in *different degrees*; and the ſenſations of harmony and diſcord in ſounds, reſemble the harmony or contraſt of colours, in all reſpects, except in the actual ſenſations and the modes in which they are excited.

The nerves of *taſte* and *ſmell* are each formed, alſo, of fibrillæ conveying the æthereal and phlogiſtic powers, diſtinctly; and the different ſenſations of taſte and odour are produced by the æthereal or phlogiſtic powers, in different proportions and ſtates of *evolution* in the various ſubſtances which are taken into the mouth or the noſtrils, acting *together*, or *ſingly*, in *various ſtates* of combination, ſeparation, and excitement.

38. *All* the organs of *ſenſe*, then, I ſuppoſe, are ſupplied with nerves, conveying the *æthereal* and *phlogiſtic powers*, but *ſingly*; and thoſe nerves are ſubject to excitement from the æthereal and phlogiſtic powers ſingly, or ſeparately excited in various degrees by different ſubſtances and means; *each* power producing a *diſtinct* ſenſation, correſpondent to its ſtate and degree of excitement.

The ſenſe of *feeling*, however, may be an exception; as it ſeems to depend upon *material* impreſſions, and not upon the *powers* excited by matter.

39. From what has already been advanced in explanation of the various functions of the living body, it appears to me evident, inconteſtably ſo, that there are *two powers* eſſentially neceſſary to produce thoſe operations; and that *each* power is conveyed by its *diſtinct nervous fibrillæ*:—it is likewiſe evident, that neither matter, nor the powers which actuate it, are *capable* of either ſenſation or thought; conſequently, there muſt be a *living principle* or *principles*, which can *feel* and *think*—which are *diſtinct* from both matter and power.

40. But we know that the *powers* in *motion*, can excite the principles of *life* or *animation*, as is evident in electricity: we know that the *powers* can excite *ſenſation*, as is evident when *light* excites the ſenſation of *colour*: and we alſo know that the principle of *life* or *animation*, can impart motion and excitement to *power*, as is evident when a *volition* in the brain cauſes a flow of the

powers along a *nerve* to throw a *diſtant muſcle* into *action.*

41. Is it then *one* homogeneous, vital principle, which *animates* the *whole ſyſtem*, or has *each power* its ſpecific *principle* of life, or animation ?

42. Either of the powers or nerves may be excited to ſenſation, or to tranſmit its excitement to the ſenſorium ; but it depends upon the *ſtate* of the *ſenſorium*, whether that excitement is *perceived* there or *not* : but, the nerve excited certainly does poſſeſs a living power ; ſo does the ſenſorium, and the one ariſes from the other.—It appears, then, that the excitement of the nerve, its power, and living principle, neither ſleeping nor waking, is really *perceived* in the *ſenſorium*, unleſs the *ſenſorial principle* be directly *attentive* to that excitement ; and the ſenſorial principle *itſelf* is *without perception*, when *not excited* by the powers or principles of the nerves, or the ideas connected with or ariſing from them : conſequently, it is allowable to ſuppoſe, that the

intellectual operations of the *ſenſorium,* depend upon *two principles,* which, acting *together,* produce *perception,* and which having the property of *reſuming,* or *paſſing through* the various modes and ſtates of action which they have been *accuſtomed to,* conſtitute, or produce thoſe various intellectual operations, which we call recollection, compariſon, reaſon, judgment, and determination.

43. If this be admitted, then, we may conclude, that *each kind* of nerve has its *diſtinct principle* of life, or animation: and by way of diſcrimination we may call the *principle* which actuates the nerves conveying the *æthereal power,* the *vital principle*; and *that* which actuates the nerves tranſmitting the *phlogiſtic power,* the *animating principle.*

44. Either of theſe *principles* is capable of being excited by its reſpective power in motion, and of communicating that excitement to the ſenſorium, where ſenſation is *perceived* if the *contrary principle* of the *ſenſorium* be preſent to *act*

with it: and either of them may, by excitement in the ſenſorium, tranſmit its power to the muſcles. But, *perception* and all the *conſequent operations* of the ſenſorium, only ariſe when the *vital* and *animating principles* are *excited* to *act together*, and have ſupplies of the *æthereal* and *phlogiſtic powers*, upon which their excitement and power of action depend; and as neither the æthereal nor phlogiſtic power can act alone, nor the vital nor animating principles can ſingly be excited to conſciouſneſs and thought, it is probable that the *medullary fibres* of the ſenſorium commune with their *powers* and *intellectual principles*, are ſo diſpoſed and conſtructed that the *æthereal* origins of the *nerves* of ſenſation and motion with their *vital principle*, ſhall *correſpond* to the *phlogiſtic* medullary fibres of the *ſenſorium* with their *animating principle*; and that the *æthereal* power and *vital* principle of the *ſenſorium* ſhall correſpond with the *phlogiſtic* origins of the *nerves* of ſenſe and volition with their *animating* principle; by which means, when either the ſenſorium or nerves are excited, the *contrary principle* at the point of contact, or where the *nerves originate*, is *ready* to act and perceive, if the ſenſorium be in a ſtate of excitement or *attention*, by the preſence of the æthereal and phlogiſtic powers being excited to flow from their ſources in the cerebrum and cerebellum, to the ſenſorium.

45. Perception and thought require the *co-action* of the vital and animating principles: their action requires *excitement* as well as powers; for excitement is only produced by the co-action of the *powers* with their reſpective *vital* or *animating principles:* when the intellectual operations are excited in any particular part of the ſenſorium, the *powers* of the ſenſorium are particularly directed to flow to *that excited part*; and when the intellectual principles are *deſtitute* of excitement, or *exhauſted* of powers, they become *quieſcent:* the powers are no longer excited to flow to the ſenſorium from their reſpective ſources in the cerebrum and cerebellum, and *ſleep*, or a ſuſpenſion of the intellectual action, takes place.

46. Were theſe conjectures admitted, it

would follow, that perception and thinking, reaſoning, judging, &c. reſemble attraction; and the *principles* producing them have a ſimilitude to the *powers* which produce attraction; for the *æthereal* power may be excited to *arrangement* around matter, and yet be *inactive*; ſo may the *phlogiſtic* power; and it is only when they come into *contact* in *ſimilar ſtates* of atmoſpheric excitement, that they *attract each other*, and draw their reſpective material centres into contact;—ſo alſo the *vital* and *animating principles* of the nerves and ſenſorium may either of them be excited, with its reſpective power, and yet neither of them, *ſingly*, can produce either ſenſation, thought, or conſciouſneſs; but, when they act *together*, that action is *perception*, *thought*, or *conſciouſneſs*, and the powers they are reſpectively connected with are brought into combination, and aſſume a new ſtate, that of fire, or heat when diffuſed into the parts around; or thoſe powers may be tranſmitted to muſcular fibres, and cauſe them to contract before they combine and conſtitute heat by flowing into the blood of the muſcle which they have made to contract.

This is a ſubject, however, of too intricate a nature to be treated thus extemporaneouſly ; I, therefore, ſhall here cloſe my inveſtigations for the preſent, and terminate my inquiries with a few general obſervations on the effects of poiſons, and on the influence of different metals when applied to the nerves of animals while they retain their living powers.

SECTION XV.

On the effects produced on living animals, by means of animal and vegetable poiſons; and in conſequence of cutting certain nerves connecting peculiar parts of the body with the brain.

1. IT is not my intention to enter into a minute diſcuſſion of the numerous experiments with animal or vegetable poiſons, which have been made by the Abbé Fontana, Dr. Monro, &c.; neither do I intend to conſider all the experiments which have been publiſhed by Mr. Cruikſhank and others, on the effects ariſing in conſequence of cutting various nerves in the living animal; I mean only, to take a general view of the more important effects which have ariſen from them, and to give ſuch explanations as the principles of my theory offer, and leave it to others to judge how far thoſe explanations are more or leſs ſatisfactory and conſiſtent,

than the explanations which have hitherto been given, and commonly received.

2. As the Abbé Fontana has made the moſt numerous ſacrifices of his feelings for the purpoſe of attaining knowledge, of any man with whom I am acquainted, I ſhall begin with his experiments firſt; not that I think the man who can look with an eye of indifference upon the agonizing tortures of animals, whoſe feelings are as acute as his own, is the more eſtimable on that account; but, becauſe thoſe modes of torture are more varied, and the effects the more numerous and diverſified.

3. I by no means, however, think it blameable to try certain experiments, deviſed by cool deliberation, the reſults of which may be productive of general good; but, I muſt confeſs that *I think* thouſands of the poor animals which were tormented and deſtroyed by the Abbé Fontana, were ſacrificed in vain! Neither can I think it by any means juſtifiable, for a man to wantonly repeat the ſame cruelties again and

again, to ſatisfy the idle curioſity of men who are not *likely* to improve the art of removing the diſeaſes of mankind, as is practiſed by ſome at preſent. In the hands of a Monro, of a Bailie, a Cruikſhank, or any profeſſor of anatomy, ſuch experiments may be acts of mercy to the animal creation; becauſe, being dextrouſly performed before numbers, they may ſatisfy their curioſity, and afford them facts for reaſoning upon, without every individual being left under the neceſſity of performing them to ſatisfy himſelf; conſequently, one experiment performed before hundreds, may prevent that experiment from being repeated hundreds of times; that is, by each individual.

4. Can I read of a dog being confined without food for thirty days, merely to know how long that poor animal would be in ſtarving to death—without horror?—Can I ſee, in idea, the cruel author of his unneceſſary ſufferings, approach him in his latter moments, and ſee him while he has any remaining ſtrength, wag his tail, and look with affection and kindneſs

upon him, and yet leave him to his cruel fate without remorſe?—I ſay, can I conſider this, and not feel compaſſion, in its moſt poignant degree, for the harmleſs, ſuffering animal, and indignation for the author of his miſery?—Surely I cannot, and I glory in my feelings!—But enough—it is not the *feelings* of mankind, but the EXPERIMENTS they have made which I have at preſent occaſion to conſider.

5. It is proved by the Abbé Fontana's experiments, that the poiſon of the viper mixed with the blood flowing *from* a vein, *prevents* it from *coagulating*; but, injected *into* a vein, the blood is *coagulated inſtantly*. This is a difficulty he could never ſurmount, becauſe he reſolutely denied every interference of the nerves in the effects produced by poiſon.

6. It is evident, however, that the coagulation *cannot* be ſimply effected by the *poiſon* acting on the *blood*, becauſe by that ſimple action the blood is *deprived* of its *natural* power of coagulating: it muſt, therefore, to a certainty,

be produced by the co-operation of ſome *additional agent* ; and what additional agency it does ariſe from, may beſt be diſcovered by attending to the other effects produced, at the time when the coagulation of the blood takes place.

7. When the poiſon of the viper or the ticunas is injected into a vein, for example, the jugular, the actions of the heart and lungs are deſtroyed, ſo as to be *incapable* of *propelling* the *blood*; and the right ſide of the heart and the lungs are found *diſtended* with *blood*, black, and coagulated.

8. The effect produced by the poiſon, then, is not ſimply the coagulation of the blood ; the *vaſcular extremities*, alſo, which have been expoſed to that poiſon in the blood, have *loſt* their *excitability*; their *muſcular* action, propelling the blood, is *deſtroyed*; the *nerves* expanded upon the ſurfaces of thoſe vaſcular extremities have *loſt* their *vitality*; they are no longer *excitable* by the powers in the blood, and no longer *capable* of tranſmitting their powers to the muſcular

fibres in thoſe vaſcular extremities, by which their blood is propelled.

9. The poiſon, then, when received into the blood, is circulated with it, and deſtroys the *vitality* of the *nerves* expanded on the ſurfaces of the *blood veſſels*, particularly at their *extremities*, as it proceeds; and as the nerves thus expanded on the ſurfaces of the blood veſſels, conſtantly receive a flow of the *æthereal* and *phlogiſtic powers* from the brain, which is accumulated in thoſe expanſions, and detained there by the vitality of the nerve, till they are excited to flow to the muſcular fibres, it muſt follow, that when the poiſon deſtroys the vital power of thoſe expanſions, expoſed to the influence of the blood, the *powers* accumulated *there* by the vital principle, muſt become *diſengaged* by the deſtruction of that vitality, and *they muſt*, therefore, *flow* into the *blood*, ready to receive them. It is, therefore, by the acceſſion of the *powers* of the *nerves* that the *blood* is *coagulated*, and the more completely the vitality of the nerve is

deſtroyed, the more ſudden and perfect the coagulation of the blood.

10. When the poiſon of the viper, or ticunas, then, is thrown into the jugular vein, it inſtantly paſſes to the heart, and from thence to the lungs, where the *involuntary nerves*, expanded on the ſurfaces of the blood veſſels, are expoſed to the poiſonous influence; the *vital* principle is *deſtroyed*; the nervous powers are no longer *detained* in the nerves; they *flow* into the poiſoned *blood* and *coagulate* it; the vaſcular extremities are *no longer excited* to act; and the circulation of the blood ceaſes.

11. But this by no means accounts for the *immediate death* of an animal, in the manner effected by the injection of the poiſon; becauſe, as ſoon as the poiſon is injected, the animal becomes univerſally convulſed, and dies.

12. If an animal be prevented from breathing proper air, or air containing the æthereal acid, the blood accumulates in the right ſide of the

heart and in the lungs; the vaſcular extremities ceaſe to act, and the blood ceaſes to flow;—but, before the animal arrives to this ſtate, *violent efforts* to *inſpire* are excited, by the powers conſtantly flowing to the nerves of the lungs; *accumulating* there for want of the excitement of the æthereal air; and *regurgitating* to the nerves and muſcles of inſpiration:—but, when poiſon circulates to the lungs, and deſtroys the vitality of the nerves there, there is *no* accumulation of powers in thoſe nerves, and *no* tranſmiſſion of thoſe powers to the nerves and muſcles of inſpiration to excite them to act: conſequently, the *poiſon* which *deſtroys* the *vitality* of the nervous expanſions in the lungs, muſt, alſo, *deſtroy* the *vital principle* of the *nerve* in its *full extent.*

13. When, therefore, the poiſon is applied to the nervous expanſion in the lungs and heart, it *deſtroys* the *vitality* of the nerves in thoſe parts; that deſtruction of the vital principle *aſcends* upwards, towards the *brain,* by which the nerves of the lungs and heart are *incapacitated* from *receiving*

any *further* flow of the æthereal and phlogiſtic powers from the brain.

14. But, thoſe branches of the *par vagum* which chiefly ſupply the lungs, and partly the heart, are derived from *all* the *nerves* of *motion*, ariſing from the brain; and the powers flowing to *every* nerve from the brain, are *partly* ſent to the nerves of the lungs and heart; conſequently, then, when the vital power of the nerves of the lungs is deſtroyed, as far as the *nerves* of *motion* from which they *ariſe*, the conſtant flow of powers from *thoſe nerves* will be *prevented* from flowing *to the lungs*, and they will flow, therefore, in *unuſual* quantities to the *muſcles* in *general*, by which thoſe muſcles will be excited to *unuſual action*: but, in a moment, the deſtruction of the vital principle of the nerves is communicated to *all thoſe nerves* of motion, from which the nerves of the lungs ariſe, and alſo to the *brain* itſelf: the regular but increaſed flow of powers to thoſe nerves quickly, therefore, becomes *interrupted*: they flow in *irregular jets*, producing convulſive motions in the muſcles:—ſoon, however, the

poiſon deſtroys the vital principle of the *brain* and *nerves*, and *death enſues.*

15. If the poiſon of the viper, of the ticunas, of opium, or of the lauro-ceraſſus, whoſe deleterious powers are the moſt evolved, be taken into the ſtomach, convulſions and death almoſt inſtantly enſue. This ſudden deſtruction of the vital principle of the brain and nerves, *cannot* be owing to the *poiſon* acting upon the ſyſtem by means of the *blood*; becauſe, admitting that the poiſon is taken into the blood, in the ſtomach, it can only, inſtantly, deſtroy the vaſcular actions *there*, but *cannot* be *tranſmitted* to the *heart* and *lungs*, without *firſt* of all being collected in the *vena portæ*, and circulating through the *liver*; which requires a length of time, by *no means* compatible with the *ſudden* deſtruction produced by the poiſon.

16. But, the ſtagnation of the blood in the ſtomach, *cannot* cauſe ſo ſudden a deſtruction of the vital principle of the brain and nerves :—the poiſon, then, *muſt act* upon the *nerves* of the

ſtomach, by deſtroying the vitality; and that *extinction* of the *vital principle* muſt *proceed* along the *nerves* towards the brain.

17. The ſtomach is chiefly ſupplied with nerves from the par vagum; and thoſe nerves like thoſe of the lungs, ariſe from *all* the *nerves* of motion proceeding from the brain; conſequently, if the vital principle of the *nerves* of the *ſtomach* be deſtroyed by the poiſon, that deleterious influence will be communicated to *all* the *nerves* ariſing from the brain; and till that deſtruction of the vitality of the nerves is actually *communicated* to the *reſt* of the *nerves* and the brain, the conſtant flow of powers from thoſe nerves into the *nerves* of the *ſtomach*, will be *gradually prevented*, as the deſtructive influence aſcends; and, conſequently, *thoſe powers* will flow in *increaſed* proportions to the *other nerves*, and produce thoſe *convulſive* motions of the *muſcles*, which ſo generally ariſe when poiſons are applied to the ſtomach.

18. If a *large* proportion of poiſon, in a *very*

active ſtate, be taken into the ſtomach, or thrown into the blood, inſtant death is produced, *without any* convulſions, or muſcular actions whatever; conſequently, the *vital principle* of the *nerves* may be *totally* extinguiſhed, *without* the *powers* in the *nerve* being in the leaſt *excited* to *flow*.

19. If, then, the poiſon of the viper be applied to the *trunk* of a nerve, the ſciatic nerve, for example, ſo generally choſen for experiment by the Abbé Fontana, it may ſo *inſtantly* deſtroy the vitality of that nerve, as to *prevent* it from imparting *any motion* to its *powers*; conſequently, as the coagulation of the blood is only effected when the *poiſon* and the *powers* of the nerves are *together* imparted to the blood, it was in vain for the Abbé to look for the *coagulation* in the *blood* of the muſcles to which that nerve was diſtributed. The poiſon could merely act upon the *vital principle* of the nerve; that might be extinguiſhed *without any flow* of the powers being excited; and, conſequently, the blood could *not* be coagulated, becauſe the coagulation de-

pends upon the *powers diſengaged* from the *nerves* as well as upon the poiſon.

20. If the poiſon, then, be applied to the trunk of the ſciatic nerve, and ſimply deſtroys its vitality, that deſtructive influence will be communicated to the brain ;—to *one ſingle portion* of the brain, from which the ſciatic nerve ariſes; for the ſciatic nerve is not like the par vagum which is connected with *all* the nerves ariſing from the brain; it is ſimply a *nerve*, extending from the brain to the *muſcles* :—the *ſmall portion* of poiſonous influence communicated to the nerve may deſtroy the vitality of *that nerve*, without being *ſufficient* to derange, or deſtroy the vitality of the *brain*; and, that that *is* the caſe, is evident, from thoſe who having been bitten by a viper, have become *paralytic* with conſiderable *diminution* of the powers of the *brain*.

21. That poiſons may act upon the nerves when applied to their *trunks*, is proved to a certainty, by the Abbé Fontana himſelf; becauſe, upon applying a ſpirituous ſolution of opium to

the crural nerves of frogs, the muſcles in which thoſe nerves terminated were deprived of motion: ſpirit of wine produced the ſame effect; a ſolution of opium in water did not ſo evidently: —what then? ſpirit of wine, at leaſt, is capable of deſtroying the vital powers of the nerves; and ſpirit of wine is a poiſon, whoſe general effects are ſimilar to thoſe of opium itſelf; only, the deleterious powers are more evolved in *one* than in *the other*.

22. Since ſpirit of wine, then, is a poiſon which deſtroys animals when taken into the ſtomach, and when injected into the blood, as the poiſons of the viper, the ticunas, the lauroceraſſus, and opium do; and ſince it evidently does deſtroy the vital principle of the *nerves* by application to them, inſtead of concluding, ſo directly contrary to experiments, that poiſons are *innocent* when applied to the *nerves*, he ought to have concluded, that certain poiſons, when mixed with the blood, or with the gaſtric fluids, may be capable of acting upon the nerves expoſed to their conjoint influence, which poiſons,

when their powers are *not evolved* by the blood or gaſtric fluids, may be *incapable* of acting upon a nerve itſelf; ſince other poiſons, whoſe principles are in a *different* ſtate of *evolution* and *activity*, *do, certainly*, deſtroy the vitality of the nerves to which they are applied.

23. But, that the poiſon of the viper may deſtroy the vitality of the nerves, for any thing which the Abbé Fontana has ſhown to the contrary, I have already explained: and that it *does*, in *ſome caſes*, is evident from the paralyſis which follows the bite of the viper, which, though ſufficient to deſtroy the functions of a *voluntary nerve*, and even the neighbouring parts of the brain, to a certain degree, is *not* capable of deſtroying the *general vitality* of the ſyſtem, when applied to the extremities of a *nerve* of *volition*.

24. An experiment made by Dr. Monro, relating to the preſent ſubject, I ſhall now introduce:—he found that when every communication between the trunk and poſterior extremities of a frog were deſtroyed, except the *ſciatic nerves*,

by injecting a ſtrong ſolution of opium under the ſkin of the *poſterior extremities*, they were deprived of ſenſibility and motion; but, the *trunk* of the body was *not* affected.

In another experiment the Doctor found, that the ſolution of opium poured into the *heart*, produced convulſions of the *legs*, when the venæ cavæ and aorta were *previouſly cut*: and he alſo found that it affected the legs in the *ſame manner*, when poured into the cavity of the *abdomen*, *after* the heart was cut out.

25. From the firſt experiment it appears, that opium applied to the extremities of the *ſciatic nerves*, deprives *them* of their powers of ſenſe and motion; but, that effect is *not* communicated to *other nerves*; and from the other experiments it is evident, that opium applied to the *heart*, or cavity of the *abdomen*, *does* affect the nerves of *thoſe* parts; and from them the effect *is* alſo communicated to the *nerves* and muſcles of the *poſterior extremities*.

26. The ſciatic nerves ariſe from the brain ;—I do not, however, mean that they are directly *ſent off* from the brain, but, that the fibres of which they are compoſed have *diſtinct origins* in the *brain*, although they paſs along with other nerves in a maſs which we call the ſpinal marrow : ſo that the ſpinal marrow is, in fact, no other than a *general aſſemblage* of the *nerves* diſtributed *from the brain* to various parts of the body, from which they are detached, in pairs, to the parts they are deſtined to influence. That this is the caſe, appears to me not to admit of a doubt ; for *volition* certainly ariſes *in* the brain, and it can tranſmit its power from the brain to *any particular* voluntary muſcle, or even to a *certain part* of ſome muſcles ; which proves that the *very fibres* of a nerve, diſtributed to *any particular* muſcle, *originate* in the *brain*, which can excite its powers to flow to thoſe fibres, and *thoſe only* :—that this volition does reſide *in* the *brain*, and that the excitement or powers which are tranſmitted to the muſcle are ſent *from* the brain, is evident from this conſideration, that if the medulla ſpinalis be *cut*, *above* the part from

which *any nerve* is ſent *off*, the volition may *ſtill* remain, or be excited in the brain, but the intercourſe being deſtroyed, it *cannot* throw the muſcle, to which that nerve is diſtributed, into action.

27. The ſciatic nerves, then, ariſe from the brain—from *one ſingle portion* of the brain; and their office is to convey the powers excited by volition, from the brain to the lower extremities. If, then, opium be applied to thoſe nerves, if it deſtroys their vital principle upon which the tranſmiſſion of their powers depends, and if that extinction of the vital principle aſcends to the brain, there it muſt ſtop: at leaſt, any further effect muſt be ſmall, as it cannot be ſuppoſed that the effect of the opium applied to ſo *diſtant a part*, and to a *ſingle nerve*, can be communicated to the *brain*, with *ſufficient power* to *deſtroy all* its *vitality*, as well as that of *all* the *other nerves*; becauſe, the ſciatic nerves, ſimply ariſe from *one portion* of the brain, and have *no* connexion with other nerves, except a few branches ſent to the intercoſtals and par vagum, by which

they convey powers flowing from the brain; and even admitting that the extinction of the animating principle of the ſciatic nerves, were to be communicated to thoſe *involuntary* nerves, ſtill, the effect could be but ſmall; ſince *their* communications form but a *ſmall portion* of thoſe nerves, which are formed from *all* the nerves ariſing from the brain.

28. But, on the contrary, when the ſolution of opium is applied to the *heart*, or injected into the *cavity* of the *abdomen*, it acts upon the *extremities* of *all* the *nerves* of the intercoſtals and par vagum, diſtributed to thoſe parts; and as thoſe nerves are formed into various *plexuſes*, the effect upon thoſe branches diſtributed to *one part*, muſt be communicated to *all*: conſequently, then, the deleterious effects of the opium on the heart or abdomen, will be communicated, not only to the intercoſtals and par vagum, but alſo to *all* the *nerves* of *motion* in the ſyſtem, as *from them* they ariſe, and *with them* they are intimately connected. The extinction of the vital powers of the *involuntary* nerves, will be communicated

to *all the other nerves,* and from them to the *brain*; hence the *convulſions* and *deſtruction* of power and vitality, in conſequence, if the quantity of opium applied be ſufficiently great.

29. If this explanation be not juſt, there is no other means of ſolving the difficulty, but by allowing that there are *certain nerves* diſtributed to the lungs, heart, ſtomach, and abdominal viſcera, along with the par vagum, which have the *ſingular property* of *conveying* the æthereal or phlogiſtic powers, in certain ſtates, applied to their *extremities, directly to the brain*; while all the nerves of motion only convey the powers *from* the brain to the parts to which they are diſtributed.

30. That this may be the caſe, is by no means improbable; for we know that pure air will ſometimes reſtore the functions of the brain and nerves, when they are ſuſpended, and motion has ceaſed, by being applied to the nerves of the lungs; and that wine or ſpirits will impart inſtant vigour and energy to the brain and

nerves, when greatly exhauſted, by being applied to the ſtomach, which muſt be effected either by the æthereal power in the lungs and the phlogiſtic power in the ſtomach, being *tranſmitted* by *certain nerves to* the brain; or otherwiſe, by the excitement which thoſe powers give to the *vital* principles of *thoſe nerves*, which *excitement* is communicated to the *brain*, as I have formerly ſuppoſed, rather than admit of a peculiarity in theſe nerves, which is not obſerved in any other; and I ſtill muſt retain my former opinion, till it be found that this *peculiarity* in the nerves of the ſtomach, &c. *does*, in reality, exiſt.

31. I ſhall conclude this ſection with a few general obſervations and remarks on the experiments made by Mr. Cruikſhank and others, on animals, by cutting the par vagum and intercoſtal nerves.

When the par vagum and intercoſtals are *both* cut, the animal is extremely affected; *reſpira-*

tion becomes painfully *laborious*; the lungs become *diſtended* with blood, and it dies.

In this experiment the animal lives *ſeveral hours*; but, if the ſpinal marrow be cut above the firſt vertebra of the neck, the animal dies *inſtantly*.

32. When the par vagum and intercoſtals are *all* cut, reſpiration becomes laborious; the actions of the ſtomach are diſordered; the actions of the heart are impaired; the lungs become loaded with blood; and the animal dies:—becauſe the functions of the lungs, of the heart, ſtomach, &c. depend upon a *conſtant flow* of the æthereal and phlogiſtic powers from the brain and nerves of motion, to the par vagum and intercoſtal nerves; which powers, flowing to the *expanſions* of thoſe *nerves* upon the *blood veſſels*, are excited by the blood, when duly ſupplied with phlogiſtic food and æthereal air, to flow to the *muſcular fibres* interwoven in the *vaſcular extremities* of thoſe parts, and cauſe them to *contract*, by which contraction the *blood* is *cir-*

culated :—conſequently, if the flow of thoſe powers to the lungs, heart, ſtomach, &c. be *cut off*, their *vaſcular actions* muſt gradually *ceaſe*; and the *blood* muſt be propelled with *diminiſhed* power and motion, as thoſe powers in the nerves become more and more exhauſted.

33. That the actions of the heart, lungs, &c. do not immediately ceaſe, when thoſe nerves are cut, is owing to this cauſe, that, although the par vagum be cut, and the ſuppoſed origin of the intercoſtals alſo, ſtill the *intercoſtals* are *largely* ſupplied with *powers* from *all* the *ſpinal nerves*; *thoſe nerves* will *continue* to receive ſupplies from the brain, ſo long as its functions remain; and, conſequently, they muſt impart a *portion* of *thoſe powers* to the *ganglia* of the intercoſtals; which, flowing to the lungs, heart, &c. will keep up the vaſcular actions there for ſome time; but, as the intercoſtals *alone*, are *not* ſufficient to keep up the natural actions of thoſe parts, the functions muſt *gradually diminiſh* in energy; the lungs will become loaded with blood; and death muſt enſue.

34. When the nerves are cut, the *reſpirations* become laborious and unnatural, becauſe the æthereal and phlogiſtic powers conſtantly flowing to the par vagum from the brain, or nerves of motion connected with them, *cannot*, then, *flow* to the lungs and diſcharge themſelves in vaſcular actions; they, therefore, by means of the peculiar communication between the par vagum and the nerves which ſupply the diaphragm and other muſcles of inſpiration, *flow*, in a conſtant ſtream, to *thoſe nerves* and *muſcles* of *inſpiration*, which are, therefore, *excited* to *full* and *frequent action*, till the *want* of circulation in the lungs *deprives* the brain of its regular ſupplies of æthereal air and phlogiſtic blood, when its functions ceaſe.

35. That the actions of the lungs, heart, &c. do not *immediately* ceaſe, when the par vagum and intercoſtals are cut, in the uſual manner, is owing to the *powers* communicated to the intercoſtal nerves by the *ſpinal nerves*, is *evident*, from the *inſtant* death which follows the cutting of the *ſpinal marrow*, where it leaves the cranium; for

then the *ſpinal nerves themſelves* have *no flow* of powers to communicate to the intercoſtals; neither have the nerves of the lungs, heart, or muſcles of inſpiration *any ſupply* of powers; in conſequence of which, their *actions* muſt *inſtantly ceaſe*; the blood muſt ſtagnate; and the brain being deprived of the excitement and powers imparted by the flowing blood muſt inſtantly loſe its functions and its life.

SECTION XVI.

On animal electricity, or the excitement communicated to the nerves by the application of metallic ſubſtances, &c.

1. MANY have been the experiments on this ſubject, by Galvani, the firſt obſerver of the influence, by Valli, Monro, Volta, Fowler, Wells, &c.; but as the effects proceed from the ſame principle, or cauſe, howſoever diverſified the means of exciting them, I ſhall not enter into any minute detail of thoſe experiments, but ſhall ſimply confine myſelf to ſuch as are the moſt ſimple and conſtant; and, therefore, the moſt ſatisfactory and the propereſt to reaſon from.

2. If a nerve be laid upon zinc, and the muſcle in which that nerve terminates be con-

nected with the zinc, by a golden probe, the muſcle will be agitated, as ſoon as the probe comes in contact with the zinc:—whether the nerve and muſcle be ſeparated from the body, or not, does not ſignify, if the vital principle ſtill remains.

3. The nervous powers, then, are excited to flow along the nerves, and that too by the metals; becauſe thoſe powers were quieſcent, and would have remained ſo, had not the metals been applied, or ſome equivalent, exciting cauſe.

4. If the nerve and its muſcle be put into water, near to a piece of zinc in the ſame water, and the golden probe be introduced into the water, ſo ſoon as it touches the zinc the muſcle is agitated.

5. It is evident, then, that water conducts this exciting power; conſequently, it is alſo evident, that neither the nerve, the muſcle, nor the metals, were in excitement *previous* to the appli-

cation of the gold probe; becauſe, if they were, the water would have conveyed that excitement from the one to the other, as well *before* as *after* the junction of the gold and zinc: and it is clear, to a demonſtration, that the exciting cauſe is *not* the *electric fluid*; becauſe, if the zinc, or gold, had been electrified before, the inſtant they had *touched* the *water* their electricity would have been *diſcharged,* without a poſſibility of bringing the two metals in contact, in contrary ſtates of electricity, in the water, which the conditions of the experiment require, ſince the zinc and the probe muſt come in *contact*, within the water, to produce the contraction of the muſcle.

6. That the effect in queſtion is *not* produced by electricity, then, is certain: in fact, no man can duly attend to the circumſtances of the two, and admit even the poſſibility of their being the ſame principles, in ſimilar ſtates of excitement; though every one muſt ſee ſo ſtriking a reſemblance, in ſome reſpects, as to feel no difficulty in admitting, that they may be the *ſame* principles, in *different ſtates* of excitement.

7. If zinc be applied to the nerve, it may be again withdrawn, without producing muſcular agitation: if gold be applied to the muſcle, it may again be taken away, without any apparent effect on the muſcle; neither of them, then, *ſingly*, excites the nerve or muſcle, ſo as to produce agitation.

8. If the zinc be applied to the nerve, and the gold probe to the muſcle, ſtill there is no agitation of the muſcle;—but, apply the metals to each other, and the muſcle is agitated:—by the contaction of the metals, thus connected with the nerve and its muſcle, then, the nerve is excited to agitate the muſcular fibres in which it terminates.

9. But, nothing is communicated:—if the metals be connected with the nerve and muſcle, by means of water, or any conductor of the electric fluids, or by a metallic chain, ſtill the muſcle is agitated when the metals come in contact, although no electric appearance can be perceived; neither can the moſt ſenſible elec-

trometers diſcover the leaſt appearance of electricity :—had the metals communicated a flow of any kind of fluid, ſimilar to the electric fluid, it would have been diſcoverable; but, no ſuch thing can be perceived, neither is the ſtate of the metals altered, with reſpect to electricity, by being in contact, from what they were before.

10. Beſides, the nerve is a conductor of electricity; if, then, the zinc were *electric* with one kind of electricity, and the gold with the contrary, ſo ſoon as they were applied to the nerve and the muſcle, they would *diſcharge* themſelves *along* the *nerve*, and agitate the muſcle, which they do not; unleſs the metals themſelves be in contact.

11. We know, however, that when the metals are in contact, they cauſe the nerve to agitate the muſcle, in the ſame manner as when the nerve is connected with the external coating, and the muſcle with the inner ſurface of an electrified jar :—in the latter caſe, we know that the

nerve is excited by the contrary kinds of electric fluids ruſhing into combination, along the nerve, by which it becomes excited to agitate the muſcle :—conſequently, as the effect is the ſame, we muſt refer it to the ſame, or a ſimilar cauſe.

12. Electricity, then, excites the nerve by the contrary electric powers, flowing in contrary directions, to combine with each other, along the nerves.—The excitement, by means of contrary metals, then, muſt be effected by the contrary powers, flowing in contrary directions, to combine along the nerves :—but, the metals had *no* ſuch powers to communicate, as is evident from par. 9 and 10 :—the nerves themſelves, therefore, poſſeſſed the powers, and the metals only *ſeparated* and *excited* them, when *ſingly* applied ; but, when they were brought into contact, they *deſtroyed* or *counteracted* each other's power of exciting the powers of the nerve, and *left* thoſe powers, thus ſeparately excited in the nerve and the muſcle, to *ruſh along* the nerve, into *combination* ; by which means, the *vital*

principle of the *nerve* was excited, to tranſmit its *powers* to the *muſcular* fibres, and throw them into action.

13. We have already ſeen (ſect. vi.) that it is an invariable law, that when the æthereal and phlogiſtic powers are made to change their ſtate, it is by *ſeparation*; and whatever *kind* of excitement is imparted to the *one* is, alſo, aſſumed by the *other*.

We alſo know that when any body is electrified with one kind of electricity, it will excite the common powers of any conducting body near it, to aſſume a contrary ſtate, or to form an electric atmoſphere of the contrary kind of electricity, not by communication, but ſimply by the attraction of the power forming the electric atmoſphere, to the contrary power always preſent, in ſome ſtate or other, in ſurrounding bodies; and we alſo know that when the conducting body, thus having its principles attracted and excited, is withdrawn from the influence of the electrified body, thoſe principles will *return* to their *former ſtate*, by *diffuſing* themſelves equally over the conducting body; or, if the electrified body be diſcharged by the contrary electric fluid, the conducting body will *loſe* its atmoſphere *without* being *removed* from the electrified body, by the attraction *ceaſing* which ſeparated its powers and excited them.

14. It is evident, then, that the æthereal power when excited around one body, will attract the phlogiſtic power of another body within its influence, (13)—and it is equally evident, that when the phlogiſtic power is excited to any particular ſtate, the æthereal power which was combined with it muſt be ſeparated from it, and muſt aſſume a ſimilar ſtate.

15. Theſe facts, then, afford an eaſy ſolution of the experiments in queſtion.

Zinc has a natural attraction to *one* of the *powers*, in preference to the other; and gold has an attraction to the *contrary power*, which they will, therefore, *peculiarly excite* at their ſurfaces.

Suppoſe that *zinc* attracts, or excites, peculiarly, the *æthereal* power, and *gold* the *phlogiſtic* power, naturally, and at all times, when circumſtances do not forbid.

If zinc be applied to a *nerve*, its excited *æthereal* power will have an influence upon the *phlogiſtic* power of the *nerve* :—for that the nerves do convey and contain *both* the æthereal and phlogiſtic powers, at all times, during life, I have already, in many inſtances, attempted to prove :—this attraction of the zinc, however, *ſingly* exerted, is not ſufficient to ſeparate and excite *both* the powers of the nerve, completely; for to effect that purpoſe, *both* the powers muſt be *attracted*.—If, then, the gold probe be applied to the muſcle, its phlogiſton will attract the *æthereal* power of the *nerve*; and by the *conjoint* influence of the zinc upon the nerve, and the gold upon the muſcle, or the extremities of the ſame nerve in the muſcle, it muſt follow, that the *powers* of the nerve will be *ſeparated* and *excited*; the *phlogiſtic* power will be attracted towards the zinc, and the gold will attract the *æthereal* power, towards the muſcle, and by that means, the æthereal power of the zinc, and the phlogiſton of the gold, will become perfectly excited alſo.

16. If now the gold be applied to the zinc, the æthereal power of the zinc will, by contaction, immediately attract the phlogiſtic power of the gold; in conſequence of which, each will *loſe* its attraction to its reſpective *power* of the *nerve*:—thoſe powers will immediately ruſh in contrary directions, to *combine*, along the nerve; the phlogiſton of the nerve attracted by the zinc will ruſh towards the muſcle, and the æthereal power excited by the gold will flow from the nervous extremities in the muſcle, to the trunk of the nerve itſelf; by which means, the *equilibrium* of the powers in the nerve will be *reſtored*;—but, by that rapid *motion* and combination, the *animating* principle of the nerve will be *excited*: the conſequence of which is, a *flow* of

the *two powers*, by their reſpective nervous fibrillæ, to the *material* principles in *muſcular* arrangement; which, by that means, are thrown into action.

17. Whether the excitement, therefore, begins at the muſcle or the nerve, is the ſame in effect, as the two powers flow in *contrary* directions; and whether the zinc be applied to the nerve or to the muſcle, is of no conſequence, as the influence is ſtill upon the nerve in both places, and *both* the powers are there.

18. If water be interpoſed between the zinc and nerve, or the gold and muſcle, ſtill the effect is produced; becauſe every conductor of electric excitement is a conductor of *this*; the chief difference conſiſting in this, that in the electric excitement each power excites a *ſecondary*, or *external* atmoſphere of wide extent, but in this ſtate, the metals give a *ſimple excitement* to one principle in preference to the other, which is *not diffuſible* or *ſeparable* from the *metal itſelf*; neither is it ſo excited as to be capable of

acquiring a *ſecondary* atmoſphere, at leaſt ſo ſenſibly as to be evident to us.

19. It may be objected, that if the excited power of the metal is not diffuſible, how then does it excite the nerve, when water is interpoſed, or other conductors, to ſuch an extent as the metallic atmoſphere cannot be ſuppoſed to equal?

The manner in which its influence is communicated is eaſy to explain; the zinc, we will again ſuppoſe, excites the æthereal power; every particle of water, like all other bodies in their common ſtate, is attended by the two powers univerſally diffuſed.

If a conductor be charged with the electric fluid A, and a conducting body with its natural powers in an unexcited ſtate be brought near it, the powers of that body will be attracted, ſeparated, and excited;—the *approaching ſide* will have a part of its common principles in the electric ſtate B, and the *diſtant* ſide of the ſame body will have the other portion of thoſe powers in the electric ſtate A;—that body would then influence another, and ſo on, to any extent, if near enough to receive the progreſſive influence; and *that ſide* of every particle *moſt diſtant* from the charged conductor, would *always* have its principle in the *ſame* electric ſtate A, as the conductor itſelf:—conſequently, the *æthereal* power of the zinc, by influencing the powers in the water, will always attract the phlogiſtic powers of the particles of the water, *towards itſelf*, and the water will, therefore, act by this *æthereal* power upon the *nerve* oppoſed to the *contrary* or *diſtant* ſides of its particles.

20. As the powers excited by the metals in their common ſtate, are but *ſlightly* excited, any peculiar alteration, or change in their ſurfaces, may produce a change in their excitements; and different parts of the ſame metal may be ſo altered, by any local change of its ſurface, as to acquire a new power of excitement: and when the powers in the nerve are abundant, or the nerve is irritated by certain acrid applications,

its vital principle may be excited to tranſmit its powers by the ſlighteſt influence; and as the blood is always neceſſary to enable the nerves to produce muſcular contraction, when it is nearly exhauſted of its æthereal power, and the contractions ceaſe, they may be again reſtored, or they may be again augmented, by applying ſuch fluids, to the muſcles, as contain the æthereal principle, ſuch as the oxygenated muriatic acid.

21. That a metal may be changed in its peculiar attraction to one or other of the powers by friction with, or application to, certain other matters, is evident from experiment, and alſo from analogy; for moſt, if not all electrics per ſe, may be made to excite *either* the æthereal or phlogiſtic electricity, by means of *different rubbers*; conſequently, there is no difficulty in admitting that a metallic probe, or rod, which naturally is peculiarly attractive to the æthereal power, may be either wholly or partially changed, by the action of other ſubſtances, ſo as to have a preference for the phlogiſtic power.

22. This being the caſe, a ſingle metal rod may become both exciter and conductor.—For example, if a probe of zinc be rubbed by another ſubſtance of a different kind, for half its length, it may then have an excited phlogiſton on one half, and an excited æthereal power on the other half.—If the æthereal end be applied to a nerve, that æthereal power will ſlightly attract and excite the *phlogiſtic* power of the *nerve*, while the æthereal power of the nerve will be ſlightly excited alſo, and recede towards the muſcle: the excitation, however, is but *ſlight*, and the ſeparation *imperfect*; becauſe the æthereal power of the nerve is not *equally attracted* with the phlogiſton:—but, if the other, or phlogiſtic end of the probe be now applied to the muſcle, it will attract that æthereal power of the nerve in the muſcle:—the powers of the nerve, then, will be completely *ſeparated* and *excited*, and they, in return, will impart a *complete excitement* to the powers of the probe:—but, at the inſtant that the æthereal and phlogiſtic powers of the probe receive this active excitement, they *attract each other*, and counter-

act each other's excitement; and, conſequently, *leave* the *powers* of the *nerve* and *muſcle* to ruſh *together* along the nerve, into their uſual ſtate; by which *commotion*, the *vital* principle of the nerve is *excited* to tranſmit thoſe powers to the *muſcular* fibres, and cauſe them to *contract*.

23. All that is requiſite, then, to this mode of exciting the nerves, while they retain their powers and vital principle, and the blood in the muſcles is not exhauſted of its powers, is, the application of two ſubſtances, or ſurfaces, *one* having a peculiar affinity to the *æthereal*, the *other* to the *phlogiſtic* power;—one muſt be applied to a nerve, the other to the muſcle in which that nerve terminates, or to a different part of the ſame nerve itſelf:—they muſt be applied to thoſe different parts immediately, or with the interpoſition of ſome perfect conductor of both powers.—Thus applied, the *one* will have a peculiar influence upon the *æthereal* power of the *nerve*, the other upon the *phlogiſtic* power; by this mutual and double influence, the powers of the nerve will be *ſeparated* and inſtantly *ex-*

cited; by that means, *each* power will inſtantly exert its full influence upon the *contrary* power in the ſubſtance applied; and will, therefore, excite *it* to a ſtate of *perfect* excitement equal to its own.—In this ſtate, when the power of the nerve has fully excited the power of the ſubſtance applied to it, and the power of the muſcle has equally excited the power of the ſubſtance applied to it, if thoſe *two ſubſtances* be brought into *contact*, the excited phlogiſton of the *one* will then inſtantly *attract*, and *combine* with the excited æther of the *other*; by that means, their attraction to the ſeparated powers of the *nerve* will *ceaſe*; and *thoſe powers* will ruſh into *combination*, and excite the *vitality* of the nerve, to produce *muſcular* contraction, as before obſerved.

If the powers of the nerve be abundant, and the exciting ſubſtances be then *ſeparated*, at the *inſtant* of ſeparation, the contrary powers of the ſubſtances will again, ſuddenly, attract the *powers* of the nerves to their *extremities*; and by that ſudden *flow* of the *powers* of the nerves in *contrary directions*, the *vitality* of the nerve will *again* be *excited* to throw the muſcles into action; as is frequently obſerved, in trying the experiments.

24. Water, it is well known, readily tranſmits the influence of the powers of the metals and nerves to each other, ſo as to enable them to excite and attract each other; but water, as perfectly as it conducts thoſe influences, does not excite either the nerves or the metals; water will conduct the influence from the nerves to the metals, when excited, but it cannot excite the nerves, becauſe it indifferently contains *both* the æthereal and phlogiſtic powers, and is *equally attractive* to *each*; but to excite and ſeparate the powers of the nerves, it requires *two ſurfaces*, *one peculiarly* attractive to *one* power, and the *other* to the *other*.

25. Water cannot excite the powers of the nerves and ſeparate them, becauſe it is equally attractive to each power, and particularly ſo to

neither; but two metals may, if one be peculiarly attractive to one power, and the other to the contrary; becauſe, being applied to diſtant parts of the nerve, they will *draw* and *excite* its *two powers* at thoſe *diſtant parts* of the nerve, from which they *cannot* return to *combination*, unleſs the *metals* be *taken away*, or the attractive powers of thoſe metals be removed from the ſeparate powers of the nerve, by *attracting each other*.—Water may convey the influence of the ſeparate powers of the metals to the nerves, by which the powers of the nerves may be ſeparated, becauſe thoſe powers of the *nerves* are *moveable*; but water cannot convey the *power* of *one metal* to the *other*, becauſe *thoſe powers* are peculiarly attracted, excited, and *detained*, by the principles of the *metals themſelves*; in the ſame manner as the *magnetic* atmoſphere is inſeparable from iron, and not conveyed by water, which water ſtill readily conveys the contrary atmoſpheres of thoſe powers in an *electric ſtate*.

26. The nerves, then, contain the æthereal

and phlogiſtic powers: when two ſurfaces are applied to diſtant portions of a nerve, *one* of which ſurfaces is capable of attracting the *æthereal*, the *other* the *phlogiſtic power*, in particular, the two powers of the nerve are ſeparated and excited, and in thoſe ſtates of ſeparation and excitation, communicate in return, a *higher degree* of *excitement* to the powers of the different *ſurfaces* by which they were ſeparated; in conſequence of which, the *æthereal* power of the *nerve* is *fixed* by attraction to *one* exciting ſurface, the *phlogiſtic* power to the *other*.

In this ſtate, if the contrary exciting ſurfaces be brought into contact, their *reſpective powers*, thus excited, will immediately *attract* each other; and by that means the powers of the *nerve* being no longer *detained* by thoſe ſurfaces, will ruſh into *combination*, along the nerve; by which rapid *motion* the *vital* principle of the nerve will be *excited* to tranſmit its powers to the *muſcular* fibres, and thus produce the *muſcular agitations*, which are the ſubject of inveſtigation.

27. The phenomena of animal electricity, as it is called, then, are produced by the ſame æthereal and phlogiſtic powers as conſtitute electric atmoſpheres; only they are in *different ſtates* of *excitement*, and not formed into atmoſpheres attracting *ſecondary* atmoſpheres around them, as is the caſe when they are excited to become electric.

The nerves, we have formerly obſerved, do not convey or contain the powers in an *atmoſpheric ſtate*; and the metals which are employed as exciters, peculiarly attract their reſpective powers, from which they are *not ſeparable*, and which they do *not excite* to the *atmoſpheric* ſtate; in conſequence of which, they are peculiarly adapted to act upon the powers in the nerves, by a ſimple and mutual communication of influence, as being in nearly ſimilar ſtates of ſimple excitation: and the contraction of muſcular fibres by common electricity, and by this metallic excitement, differ in this reſpect, that in electricity the contrary electric fluids are *communicated* to diſtant parts of the nerve, and ruſh in contrary directions to combine along the nerve, while in this metallic influence, the *powers* of the *nerve itſelf*, which were *ſeparated*, by contrary attractions to *diſtant parts*, ruſh into *contact*, by becoming *diſengaged*, in conſequence of the contrary powers which attracted and ſeparated them, withdrawing their attractive influence from the powers of the nerves to attract each other, when immediately in contact: ſo that electricity excites the vital principle of the nerves, by the rapid flow of the *foreign* electric powers; but in this metallic excitement, the vital principle is excited by the rapid flow of the *powers* of the *nerves themſelves*, to regain the *equilibrium* which was *deſtroyed* by the metallic influence. In both caſes the *motion* of the powers excites the *vital principle* of the nerves to tranſmit the æthereal and phlogiſtic powers, by their reſpective nervous fibrillæ, to the material particles in muſcular arrangement; where, by exciting the powers in the blood, thoſe particles are attracted towards each other; the muſcular fibres they form are ſhortened; and the two powers combining at the inſtant of their diſcharge into the blood, form fire, which diffuſing itſelf in the blood, conſtitutes the *heat* which is conſtantly generated by muſcular action during life.

28. The reaſon why neither mechanical ſtimuli, nor the metallic exciters, produce motions of the *involuntary* muſcles, by being applied to the involuntary nerves, may be eaſily ſeen, by only conſidering that the nerves which are diſtributed to the parts whoſe actions are *involuntary*, are *expanded* upon the *ſurfaces* of the extremities of the *blood veſſels*, in the ſtate of reticulated, or medullary *plexuſes*; and that it is from *thoſe plexuſes* that the nervous fibres are ſent to the *muſcular fibres*; conſequently, an excitement given to an involuntary nerve, can proceed *no further* than this *peculiar expanſion*; and to produce the *action* of thoſe involuntary muſcles, the powers in theſe *nervous expanſions, themſelves,* muſt be *excited,* before they can be made to flow to their reſpective muſcular fibres, and cauſe them to contract.

Having thus paſſed through the ſubjects I had propoſed to myſelf for inveſtigation, but in a much more ſlight and extemporaneous manner than I at firſt intended, I ſhall now lay down my pen for the preſent.—I have attained my object in writing, in the amuſement which the inveſtigation of my ſubject has afforded me, and I offer the ideas which have occurred, to thoſe who may be diſpoſed to attend to them.

FINIS.